SCIENTIFIC AMERICAN

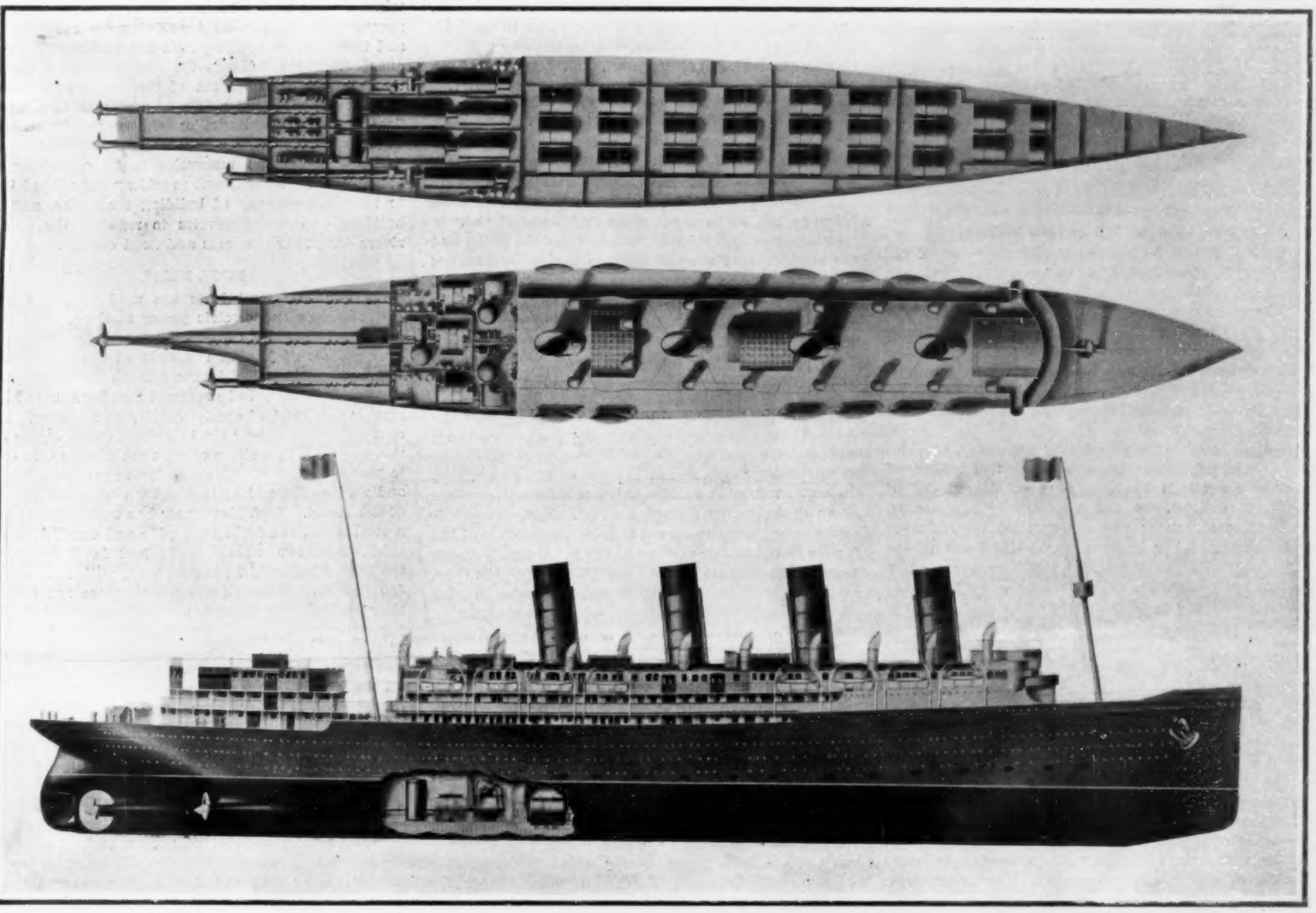
[Entered at the Post Office of New York, N. Y., as Second Class Matter.

A POPULAR ILLUSTRATED WEEKLY OF THE WORLD'S PROGRESS

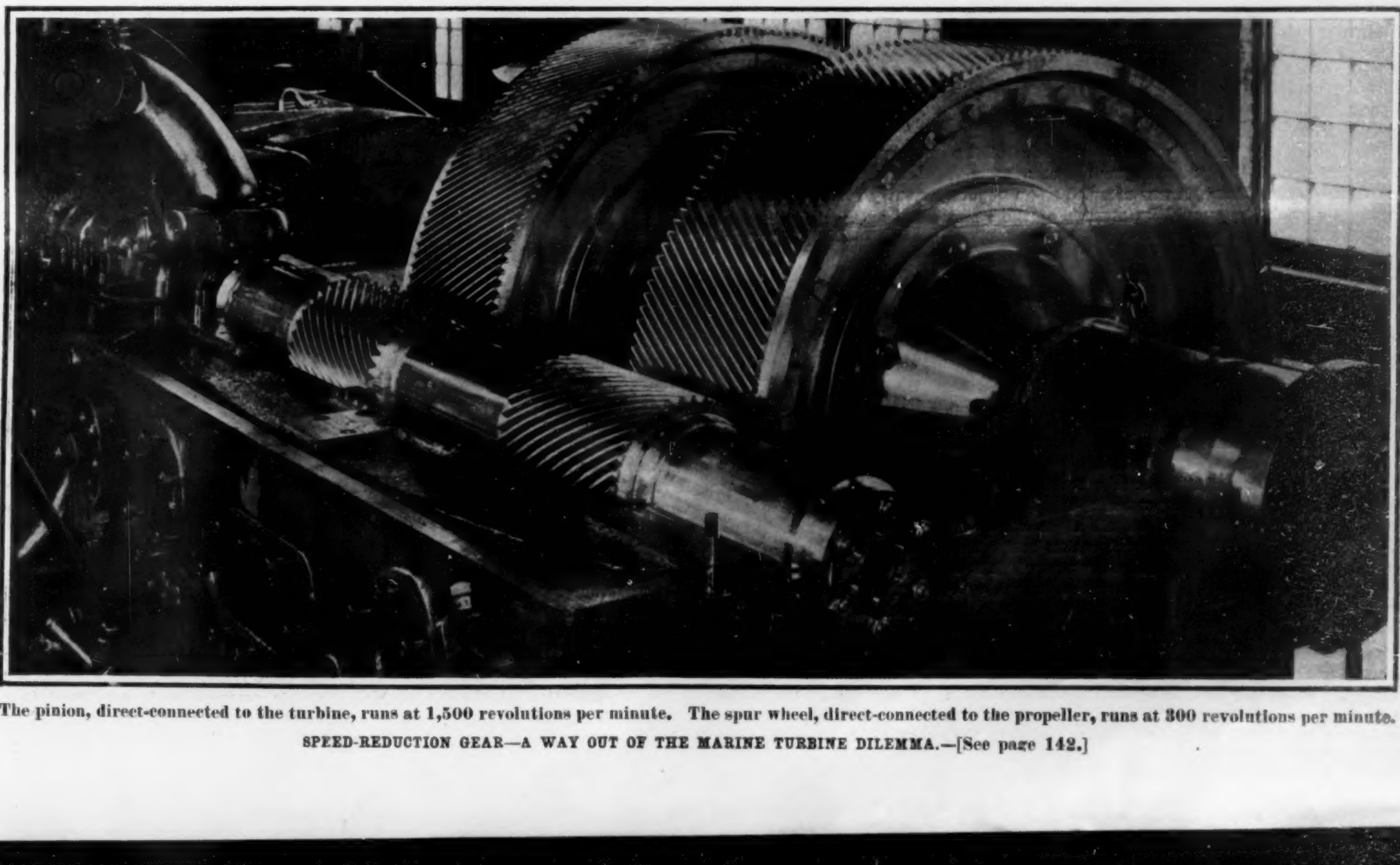
Vol. CII.—No. 7.
ESTABLISHED 1845.

NEW YORK, FEBRUARY 12, 1910.

10 CENTS A COPY.
$3.00 A YEAR.



The upper engraving shows the space occupied by the boilers and engines of the "Mauretania." The two lower engravings demonstrate the large saving in space resulting from the use of high-speed turbines, driving, through reduction gears, three slow-speed propellers. They would save 1,600 tons of coal and over $5,200 on each transatlantic trip.



The pinion, direct-connected to the turbine, runs at 1,500 revolutions per minute. The spur wheel, direct-connected to the propeller, runs at 300 revolutions per minute.

SPEED-REDUCTION GEAR—A WAY OUT OF THE MARINE TURBINE DILEMMA.—[See page 142.]

SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO., Inc., - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

CHARLES ALLEN MUNN, *President*
361 Broadway, New York.
FREDERICK CONVERSE BEACH, *Sec'y and Treas.*
361 Broadway, New York.

TERMS TO SUBSCRIBERS.

One copy, one year, for the United States or Mexico	$3.00
One copy, one year, for Canada	3.75
One copy, one year, to any foreign country, postage prepaid, 18s. 6d.	4.50

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (established 1845)	$3.00 a year
Scientific American Supplement (established 1876)	5.00 "
American Homes and Gardens	3.00 "

The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., Inc., 361 Broadway, New York.

NEW YORK, SATURDAY, FEBRUARY 12th, 1910.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

CANADA AND THE QUEBEC BRIDGE.

ENGINEERING and architectural works of the first magnitude are to no little degree an expression in concrete form of the character of the people by whom they are built. It would be difficult to define the extent to which our impressions of the ancient Greek are based upon the architecture of his noble shrines and temples, or how far our respect for the later Roman is due to feats of engineering skill that would do credit to our twentieth century civilization.

Because of the skill and daring which are, or seem to be, involved, the design and erection of bridges of unusual magnitude has ever been considered one of the most difficult, we had almost said spectacular, feats of construction; and the successful erection of such structures has brought world-wide fame to the engineer, and distinct national credit to the country in which the work was done. Thus, the Forth Bridge stands to-day as one of the noblest monuments of constructive engineering in the whole of the British empire, and a memorial to the man who was responsible for the design has recently been placed in Westminster Abbey. So too our own beautiful and dignified Brooklyn Bridge over the East River is a lasting tribute to bridge engineering as individualized in America, and the city of Trenton has recently unveiled a monument to the memory of Roebling, the father of long-span suspension bridges.

But that selfsame notoriety, which brings international fame to the man and the people who carry great engineering works to a successful issue, must, in the very nature of things, throw a proportionate shadow of discredit, when one of these great structures falls in utter ruin and, as in the case of the Quebec Bridge, carries nigh upon one hundred souls to destruction. This fact was frankly recognized at the time by the engineering and technical press, both in this country and in Canada; and it was realized to be a matter of national importance that, when the bridge came to be rebuilt, the new structure should not only be perfectly stiff and strong, but that it should embody such architectural treatment as would render it æsthetically pleasing to the eye, and worthy of that great school of bridge engineering which has sprung up and flourished in the Western Hemisphere.

When the Canadian government took hold of the matter and lent all its powerful prestige and financial assistance to the scheme, it was accepted as an augury that the new bridge would be worthy of the great Dominion across the border line. We have to confess, however, that the bridge which it is now proposed to build is decidedly disappointing. The type selected and the method of treatment are not up to the latest standards of bridge engineering. In other words, the design is distinctly commonplace. Æsthetically it has not a single redeeming feature.

In redesigning the bridge, the Canadian government could have made more sure of securing the best possible designs, if they had thrown the bridge open to world-wide competition. We should then have learned whether the strongest, most economical, and most beautiful bridge could have been secured under the cantilever or under the suspension system of design. Personally, we believe that on all three counts it would be possible to produce a suspension bridge that would be greatly superior to the structure which it is now proposed to build. The suspension bridge, especially when built of these great proportions, is a far easier bridge to erect, not being subjected to those heavy erection stresses which are the peril of large cantilever erection. Moreover, the essential elements, namely, the anchorages, the towers, and the main cables, are at all times entirely free from suspicion, and may be erected with the absolute certainty that they are well within the limits of safe construction. With these main elements assured, it is possible for failures to occur in subordinate elements, such as the suspenders and stiffening trusses, without in the least endangering the integrity of the bridge as a whole.

Not so, however, the cantilever bridge, the greater part of whose intricate framework is in compression. Let but one among the multitudinous members of the main trusses fail, and the whole structure will be thrown into immediate and absolute ruin—as witness the mass of tangled steel now lying in the St. Lawrence River.

For the credit of the profession of bridge engineering in the New World; for the prestige of the great and growing people of Canada; and above all for the greater safety of the public at large, we trust that, before the final plans of this great bridge are adopted, the Canadian government will take steps to make it certain that the final bridge will, from every point of view—engineering, architectural, and artistic—be the noblest work of its kind yet erected in any country.

CAUSES OF THE PARIS FLOOD.

THERE appears to be a consensus of opinion among the French scientists that the causes of the recent phenomenal rise of the Seine, when it reached the record height of 31 feet 2 inches, are to be found more in geological than in meteorological conditions. The basin of the Seine and the streams that are tributary to that river consists of a light absorbent soil; and, as the slopes are gentle, any sudden precipitation is ordinarily absorbed by the ground. In winter, when the soil is either frozen or saturated by the rains, there is a risk that the run-off of a heavy precipitation will be so large and sudden as to overtax the capacity of the river channels. These conditions obtained to a marked degree during the recent continuous heavy rainfall and flood. Meunier, the geologist, is of the opinion that the heavy rains preceding the flood found the soil of the Seine watershed so thoroughly impermeable because of saturation, that the water ran off as swiftly as it would from the surface of an asphalted or cemented street. Furthermore, it seems to be generally agreed that the denudation of the forests in the higher regions of the watershed has been a contributory cause to the flood. Not only do the trees assist evaporation, but the forest undergrowth also exerts a material influence in retarding the flow of the water.

Referring again to the question of the prevention of future floods at Paris, regarding which we made editorial comment last week, there is an alternative plan to that of dredging or widening the channel and the removal of river piers which, were it not for the enormous expense involved, would afford an absolute safeguard against future disaster. We refer to the heroic measures employed by the Austrian engineers to prevent the flooding of the city of Vienna by the river Danube. This consisted in cutting an artificial channel entirely around the city, through which, after the river reaches a certain elevation, all the surplus waters are diverted and discharged into the river below the city. It would be possible to create a similar by-pass around the city of Paris; but the cost, due to the great value of the land which would have to be condemned, would probably be found to be prohibitive.

WATER CONSERVATION IN NEW YORK STATE.

AFTER about three years of investigation of the subject of water resources, the State Water Supply Commission estimates that 1,500,000 horse-power of water energy is running to waste every year in the State of New York, and that if this were developed according to plans drawn up by its engineers, the State would realize a yearly rental of at least $15,000,000.

As a result of its investigation of the watersheds of the Hudson, Genesee, and Raquette rivers, the Commission has located and surveyed four reservoir projects for the development of water power and the control of floods. These are the Sacandaga and Schroon Lake reservoirs on the Hudson, the Portage reservoir on the Genesee, and the Tupper Lake reservoir on the Raquette. The Commission considers that the Hudson River, because of its size and the large population and important industries of the cities situated along its banks, should receive the first consideration in any system of conservation that may be adopted; and it recommends the construction at a point on the Sacandaga River, 50 miles north of Albany, of a dam and storage reservoir of 29 billion cubic feet capacity. Such a dam would convert 30 miles of the present river valley into an artificial lake of the size of Lake George.

The principal object of this reservoir would be to hold back and store the flood waters, and afford relief during the low-water conditions of the summer to the various power plants along the Hudson, by releasing sufficient water to maintain the level of the river at the desired stage for operation of the hydraulic plants. In addition to the great benefits afforded by such control of the stage of the river water, the power developed directly in connection with the big dam would be transmitted electrically to such towns as Albany, Troy, Mechanicsville, Glens Falls, Utica, Schenectady, and other less important communities lying within the zone of economical electrical transmission. It is estimated that the reservoir would cost $4,650,000; that the total yearly fixed charges and maintenance would amount to $237,700; and the annual gross earnings $427,500, leaving an estimated annual net revenue to the State of $189,800. The Commission estimates that on this basis the cost of the reservoir would be refunded to the State in fifty years, at the end of which time it would be the sole owner of the works, which would yield a perpetual income from the sale of the stored-up water.

The Commission advises that the work be undertaken by the State, because under State control the necessary funds can be provided more economically, and the interests of the public can be absolutely safeguarded. It recommends the enactment of a law authorizing the development of the power of the Hudson River; the construction of a storage dam on the Sacandaga at Conklingville; the amendment of the Constitution to permit the flooding of State lands in building storage reservoirs to be owned by the State; another amendment providing for a bond issue to meet the expense of building reservoirs, and the building of other reservoirs to regulate the flow of rivers for power purposes and flood control.

STEEL BELTS.

IN Germany steel belts are used in many large factories and electric power stations. The principal difficulty connected with their employment is that of joining the ends of the belt. These ends are now provided by the makers with steel plates which need simply to be screwed together. It is necessary to use steel of special quality and temper. It is advantageous to cover the belt wheels with coarse canvas, to which thin slices of cork are attached, in order to prevent slipping. The cork lasts practically forever and reduces the sliding to less than one-tenth per cent of the travel. Prof. Kammerer has experimented with a steel strap, two-fifths inch wide and one-fiftieth inch thick, with two wheels, eight feet in diameter, for the transmission of 16 horse-power, with a tension of 440 pounds. Although the wheels were not covered, they worked very silently, even at a speed of 200 feet per second. The maximum slipping was one per cent of the travel, and the loss of energy due to this cause was inappreciable.

Steel belts possess the following advantages: The energy is transmitted without slipping and almost without loss; the belts do not stretch, their width may be reduced to between one-third and one-tenth of that of leather belts, transmitting the same power, consequently the wheels may be narrower and lighter and the workshop less darkened by them. The steel belts do not deteriorate appreciably, they may be used in damp places and do not appear to be attacked by smoke or acid. They allow the attainment of velocities of 100 feet per second, and are consequently very suitable for use with turbines. The required tension is one-tenth less than that of leather belts transmitting the same power, because of the difference in weight, from which results an additional economy, owing to the diminished friction on the bearings. Much room can be saved by using steel belts because their efficiency does not depend upon their length. They can be used horizontally in place of gearing. The makers assert that they cost less than leather belts of good quality.

The oldest steel belts have been in service two years. In a Berlin factory a leather belt 24 inches wide was replaced by a steel belt 4 inches wide which transmits about 250 horse-power. The belt, after two years' use, shows no indication of wear. The only objection to steel belts is that they are not easily seen, and consequently may cause accidents if they are not carefully guarded.

A remarkable phenomenon was observed during a thunder shower in Finland in the summer of 1908 by V. J. Laine, who was making meteorological observations for the Finnish scientific society. The shower approached from the east and the thunder, which had been heard at intervals during a half hour, ceased before any rain fell at the place of observation. During approximately the same half hour the eastern horizon was completely spanned by a double rainbow, which likewise vanished before the rain came. Immediately after each peal of thunder the colors of both bows, and especially those of the secondary bow, became confused and indistinct, and the whole double rainbow appeared to vibrate rapidly. Laine explains this singular phenomenon, in accordance with the Airy-Pernter theory of the rainbow, by assuming that the concussion of the air which produced the sound of thunder, also increased the diameter of the rain drops from less than 1/250 inch to between 1/50 and 1/25 inch. If this assumption is confirmed it will furnish a valuable contribution to the theory of thunder storms, which is still incomplete.

ENGINEERING.

According to a recent dispatch, a contract for the construction, at a cost of $500,000, of a dam which will form part of an irrigation scheme in the southern section of the island of Porto Rico, has been awarded to native engineers, who secured the award in competition with four American firms. The total cost of the scheme is $3,000,000.

The heaviest rainfall ever recorded for a single day on the Isthmus of Panama occurred during the great flood of last December, between the hours of 10 A. M. December 28th and 10 A. M. December 29th, when the rain gage at Porto Bello showed a fall of 10.86 inches. The total fall for the month was 58.17 inches, which is equal to an average rate of nearly two inches a day.

The stern frame, rudder, and brackets for the new White Star liner "Olympic," which were recently supplied by the Darlington Forge Company, are the heaviest ever cast for a steamship. Their total weight is 289 tons, made up as follows: Stern frame, 70 tons; after boss arms, 74 tons; forward boss arms, 45 tons; and rudder, 100 tons. The total weight of the same parts as cast for the "Mauretania" was 220 tons.

The rapid elimination of the sailing vessel is shown by statistics recently given by a German paper. In the twenty years between 1888 and 1908 the percentage of sailing vessels has declined in the merchant marine of Great Britain from 44.1 to 12.6; of Germany, from 62.1 to 19.1; of the United States, from 80.7 to 30.9. In the merchant marine of France, however, but little change has occurred, the respective percentages being 47.9 and 47.2.

According to the French paper Matin, the Minister of Marine is asking for the construction of two dreadnoughts of 23,000 tons each in a programme which has been recently submitted to Parliament; and he has sanctioned the arrangement of turrets adopted by the Superior Council of the Navy, which recommended two turrets containing three guns and three turrets with two guns. There will be eighteen unusually powerful guns in the secondary battery, and the speed is to be twenty knots.

The locomotive recently built for the electric operation of trains through the Cascade tunnel of the Great Northern Railway, where the electrical equipment extends for about six miles, weighs about 120 tons and is furnished with four 3-phase 400-horse-power motors working on a 500-volt, 25-cycle circuit. The pressure on the line is 6,000 volts, which is reduced by transformers carried on the locomotive. The power plant, which is driven by water power, has sufficient capacity for the operation of sixty miles of the line.

The Public Serv.ce Commission has recently adopted an order requiring the New York Subway operating company to install on all subway cars destination signs, similar to those now used on some of the cars of each train. The company must also post in all stations, near the ticket office, a map showing the locations of its routes and the streets intersecting the subway line; and all stations must be equipped with illuminated signs, placed on the subway walls, for the purpose of warning passengers that they are approaching the station.

It is claimed that the lighthouse establishment of the United States government is the most complete and efficient in the world. On June 30th, 1909, the service included no less than 1,643 lighthouse keepers; and during the fiscal year of 1910, 61 additional lights, requiring the services of 47 keepers, will be established. Legislation is being sought for the establishment of three additional lighthouse districts, covering Alaska, Porto Rico and the naval station at Guantanamo, and the Hawaiian Islands. The cost of the establishment last year was $5,357,000.

In a recent communication to a New York paper, Mr. Hudson Maxim shows the futility of attempting to work any serious destruction by the dropping of dynamite from a flying machine. He states that the destruction effected would be very much less than anyone not acquainted with the action of high explosives would suppose; and that many tons of dynamite might be exploded in the middle of Madison Square without any more serious damage than the blowing out of the windows of adjacent buildings by the rush of air toward the explosion to fill the void formed by the uprush of the heated gases and air.

A word of warning has recently been given by J. N. Bailey, an English engineer, to those who are contemplating an increase of their power plant by utilizing the exhaust steam of reciprocating engines in a low-pressure turbine. He states that there are cases in which a positive loss would occur if the exhaust steam were used in a turbine in preference to a feed-water heater. In one installation which came under his notice, the major part of the latent heat in the steam, which had been used efficiently in the feed heater, was wasted in the condenser into which the turbine exhausted; for, while some 90 per cent of the heat from the steam could be utilized in the feed heater, only about 8½ per cent was recovered in the turbine.

ELECTRICITY.

Less than a year ago the New York Public Service Commission of the Second District issued an order limiting the number of passengers that could be carried on each car of the Pine Hills line in Albany. There was so much public dissatisfaction with this restriction that the order has recently been withdrawn.

A report on the tie and pole consumption in 1908 has recently been issued by the Census Bureau. The total number of ties purchased by electric railways for the year was 6,425,368, of which 4,592,195 were hewn and the rest sawed. A large majority of the ties were oak, the number being 2,414,403; chestnut comes second with 1,282,128; while Southern pine and cedar follow with 944,690 and 850,687 respectively. The number of poles bought by electric railways and electric light and power companies was 531,497, which is considerably less than the number for the previous year. The majority of the poles were cedar, viz., 285,689; chestnut comes second with 166,050.

In place of the ordinary windmill type of tower hitherto used for transmission lines, a new form of tower is now beginning to find favor. It consists of two columns spaced a short distance apart and connected by horizontal members. The plane of the tower is transverse to the direction of the line, and at its upper end it supports a cross arm on which the transmission lines are supported. The advantage of this construction over the rigid windmill type is the fact that in case of a break in the line each tower would give somewhat and distribute the strain, thus preventing the towers from being pulled over one after the other.

The Illinois traction system covers a territory 90 miles wide and 225 miles long. Much new work is being done along the lines of this system which requires the general manager to make frequent trips from place to place. To prevent loss of time he has had a sleeper and office car built, in which he can conduct business while *en route* and which will carry him over night from one point to another. The manager's car is well equipped with all the conveniences that he might desire on his trip. It is provided in the forward part with an office room so arranged that it can be converted into a bedroom with four berths separately curtained off. In addition to this there is a dining room and kitchen. The over-all length of the car is 62 feet.

In the recent report of the Royal Commission on Canals and Inland Navigation of the United Kingdom, the following conclusions are reached on the question of electric haulage on canals: namely, that a greater regularity and uniformity of speed may be maintained; that there will be less erosion of the canal banks from waves; that there will be an economy in the size of the locks because the storage capacity of barges is not taken up with propelling machinery as in tugs and steamboats; and that the electric power can be utilized for operating the locks and even for factories along the canal. The experiment was made in France not long ago of providing for horse and electric haulage side by side, but this proved to be inexpedient because the electric traction was constantly retarded by the slower horse-drawn boats.

One of the exhibits at the recent Chicago Electrical Show, which attracted considerable attention, was the government aeroplane fitted with a wireless telegraph receiving and sending system. The chief difficulty in fitting up an aeroplane for wireless telegraphy lies in the fact that it is strung with wires used for bracing the parts and these interfere with the reception of the message on the short antennæ available on such a machine. The difficulty was overcome by stringing three strands of No. 14 copper wire along the under surface of the upper plane and connecting these strands with a loop of wire strung about the runners of the aeroplane. Conditions in the Coliseum were not such as to permit of demonstrating the advantages of such a system of antennæ, but nevertheless it was possible to carry on telegraphic communication between the aeroplane and a station in the annex of the Coliseum.

A novel proposition was presented before the recent meeting of the American Institute of Electric Engineers by Prof. W. S. Franklin and Mr. S. S. Seyfert. They propose to reduce the length of single-phase series motors, so that motors of higher horse-power can be accommodated in the space between the drivers of a locomotive. The reduction of length is effected by using a stationary exterior armature and a revolving field and removing the commutator to any convenient point. The commutator would be stationary and the brushes would have to be revolved about it by connection with the field. This would provide more space for the armature windings, which in this type of motor should be stronger than the field, and would enable a better utilization of the space ordinarily occupied by the commutator. The advantage of having the commutator accessible and constantly in view would offset the mechanical disadvantages of separately revolving the commutator brushes.

SCIENCE.

Count Plunkett, the Director of the National Museum of Science and Art, Dublin (Ireland), has received notice of a bequest of £5,000 to that institution, left by Mr. Patrick Murphy of Newry.

A crew of eleven map makers of the Geological Survey, under the leadership of Chief Topographer C. H. Birdeye, are mapping the Hawaiian Islands. Their work will occupy all told about eighteen months, by the end of which time it is thought that they will have succeeded in making detailed maps of Kauai, Oahu, Molokai, Mauri, and Hawaii. This work is preliminary to a possible extension of the reclamation service of Hawaii.

Are the senses ever vicarious? The question is discussed in Nature by Prof. McKendrick and by several blind men. According to one correspondent the popular notion that when a person loses his sight he is compensated by the gift of ability in one, if not all, of his other faculties, is absurd. He points out that the imputation of striking ability does not enable a specially talented blind man to earn his livelihood by the exercise of that ability. The blind are credited with powers in music, basket making and the like, but when they assert their right to live the ordinary lives of citizens they are not permitted to do so.

With the ordinary moving picture machine photographs 2.5 by 1.9 centimeters are taken at about the rate of 16 per second, which is much too slow for taking a picture of a bullet or other projectile in flight. Even if the rates were 60 per second no satisfactory results could be obtained. In a recent number of the Zeitschrift Instrumentenk., C. Cranz describes a ballistic kinematograph apparatus which gives a time interval of 1/5000 of a second, so that shot photographs can be readily obtained, and from these the velocity of the shot can be found. The pendulum used makes electrical connections at different points of its swing, and these are utilized to obtain the photographs.

The last opposition of Mars, although eagerly welcomed by observatories of the world, has by no means settled the perennial problem of Martian surface markings. Mr. Lowell still insists that he sees the canals. Prof. Ritchey has not succeeded in photographing them, and Antoniadi still doubts the existence of the canals. It would seem that the time has come for astronomers to reach some definite agreement, and accordingly Mr. R. G. Aitken in a recent number of Science suggests that Mr. Lowell should invite two or three students of planetary detail, such as E. E. Barnard, W. H. Pickering, and E. M. Antoniadi, to come to Flagstaff to join him in observing Mars at its next opposition and thus settle once and for all what is really seen at Flagstaff.

Commander Peary has placed before the Board of Managers of the National Geographic Society a proposition in behalf of the Peary Arctic Club, to the effect that the Geographic Society join with the Peary Arctic Club in an Antarctic expedition, the Arctic Club to furnish as its share of equipment the steamer "Roosevelt," used by Commander Peary on his North Pole trips, and the Geographic Society to furnish funds for the other expenses to the amount of $50,000, the expenses above $50,000 to be borne equally by the Geographic Society and the Peary Arctic Club. Commander Peary declines to head the expedition himself, believing that the work should be intrusted to younger men. Should the plan be carried into execution, it is not unlikely that almost all members of the successful Peary North Pole expedition will proceed to the Antarctic in the "Roosevelt."

Prof. Frank H. Knowlton of the U. S. Geological Survey, has just published in the Smithsonian Miscellaneous Collections a short paper entitled "Descriptions of Fossil Plants from the Mesozoic and Cenozoic of North America." The paper includes descriptions of two new fossil chain-ferns, the first of which, called *Woodwardia maxoni*, was found in the Fort Union formation near Rock Springs, Wyoming. It is of special interest from the fact that it is very closely related to the common chain-fern so widely distributed over eastern North America from Nova Scotia to Ontario and Michigan, and south to Florida, Louisiana, and Arkansas. The other new species which he names *Woodwardia columbiana* is from the Pleistocene and was found at the Cascades of the Columbia River in Oregon. It, likewise, resembles closely a living species originally described from Mexico, but also found in Guatemala, Arizona, California, and Washington. Prof. Knowlton also describes a *Dennstaedtia americana*, which is characteristic of the Fort Union formation, never having been found outside of it. This fern has its closest affinity with a living species found widely spread over China, Japan, tropical Asia, Polynesia, and Madagascar. These three new ferns were found in excellent condition, showing the fructification, and are of special interest on account of their close resemblance to forms now living, a very unusual experience with fossil plants.

A NOVEL AMERICAN MONOPLANE

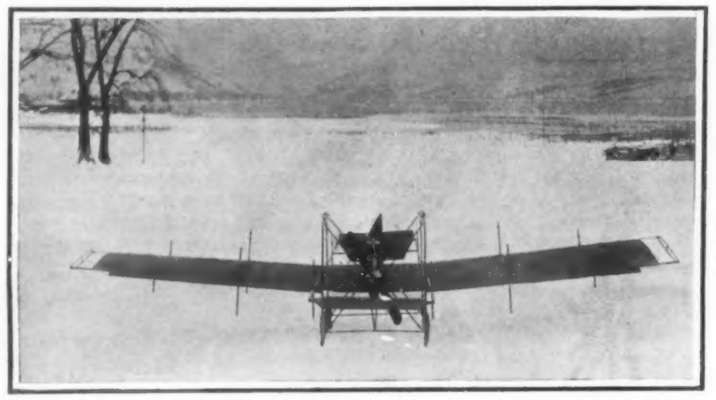
The monoplane illustrated herewith is one of the most novel aeroplanes which has thus far been produced. It is the invention of Mr. A. L. Pfitzner, who, for some time past, has been associated with Mr. Glenn H. Curtiss in the production of his aeroplanes.

This new monoplane, while resembling the Curtiss biplane in some features, is a distinct departure from the usual type of single-surface machine, such as produced abroad by Bleriot and the Antoinette Company. Unlike these machines, there is no square or triangular body extending the length of the machine and carrying a pair of wings near its front end. In place of this, there is a single plane mounted upon four vertical wood struts at its center, and having a fixed horizontal tail 10 feet at the rear and a single-surface horizontal rudder 14 feet in front. The vertical rudder is placed in front just above and at the center of the horizontal rudder. Both rudders are therefore always within the view of the aviator. They are controlled by a single wheel placed vertically in front of the aviator. This wheel also operates sliding panels on the under side of the monoplane at each end, for the purpose of maintaining the transverse stability. The fact that all three controls are operated by a single wheel makes this machine the simplest to drive of any thus far produced.

The plane has a spread of 36 feet, and a fore-and-aft width of 6 feet. The plane itself is but 31 feet x 6 feet, equivalent to an area of 186 square feet. The sliding wing tips are each 2½ feet by 5 feet from front to rear. The horizontal rudder is 6 x 3 feet in size, and the vertical rudder 3 feet long by 2 feet high. The dimensions of the tail surface are 6 x 2 feet. The total weight of the machine, the tanks being filled with 6 gallons of gasoline and 1 gallon of oil, and the radiator with 1½ gallons of water, is 430 pounds. The weight carried per square foot is therefore slightly more than 3 pounds.

The four vertical posts forming the chassis terminate in forks of seamless steel tubing, each of which carries a 20-inch pneumatic-tired wheel. The posts are spaced apart by steel-tubing braces and by wooden skids extending from the front to the rear. The front edge of the main plane is mounted upon these uprights 46 inches above the ground. The rear edge, which is formed of steel cables stretched over the ribs, is 10¼ inches lower than the front edge where it crosses the main vertical uprights. The ribs have a slight curvature of about 1 in 19, the camber being 3¾ inches in the length of 6 feet. The center of pressure is located about 18 inches back of the front edge of the plane. The ribs are laid upon two main spars running the entire length of the machine, the foremost of which forms the front edge of the plane, while the rear one is 10 inches in advance of the rear edge and rests in sheet steel sockets attached to the heavy main ribs that connect the central vertical uprights. At suitable distances from the center of the machine, on these front and rear spars, vertical struts are attached to them for the purpose of trussing the plane. The 25-horse-power 4-cylinder, 4-cycle Curtiss water-cooled motor is mounted upon two laminated beams extending from a cross tube at the rear through the monoplane surface to the front edge. The rear of the motor is substantially braced by four diagonal tubes, as can be seen in one of the photographs. The propeller, especially designed by Mr. Pfitzner, is 6 feet in diameter and gives 235 pounds thrust at 1,200 R. P. M., or 9.4 pounds to the horse-power. The oil tank is seen just below the surface of the plane in the photograph just referred to. The oil is cir-

(Continued on page 150.)



Rear view of monoplane, showing novel sliding wing tips

This view also shows the fixed tail at the rear and the horizontal rudder, with vertical rudder above it, in front of the single plane.

Mr. Pfitzner at the control wheel of his monoplane.

This view shows the single control wheel, the power plant, and the ribs and trussing of the plane.

THE FIRST AMERICAN MONOPLANE TO FLY.

NEW OVERHEAD ELECTRICAL CONSTRUCTION ON THE N. H. R.R.

The New York, New Haven & Hartford Railroad Company is so well satisfied with the operation of its electrical zone from Stamford to New York, that it has decided to extend the electrification for another forty miles to New Haven. The company is also

(Continued on page 154.)

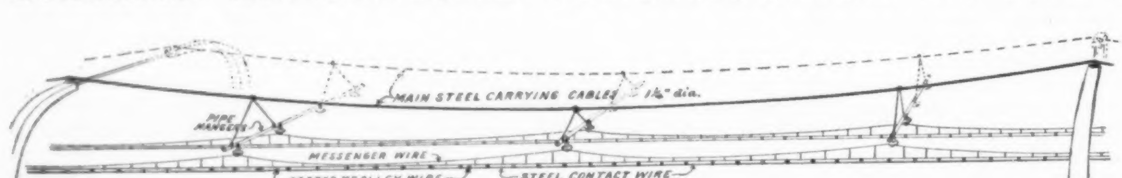
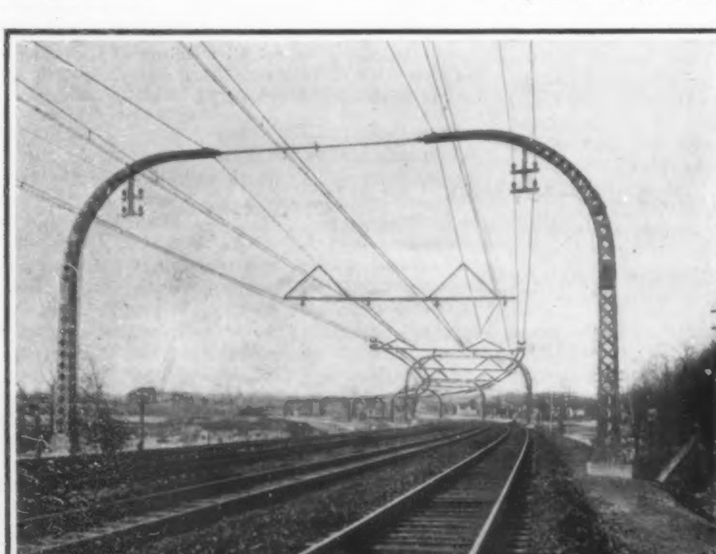


Diagram showing details of new overhead construction.



General view at Glendale, showing the light and pleasing appearance of the construction.

Near view of a pair of curved supporting columns, showing a triangulated pipe hanger, suspended from the two 1¼-inch main carrying cables

THE NEW OVERHEAD SYSTEM OF THE NEW HAVEN RAILROAD ELECTRIFICATION.

SMOKELESS POWDER—METHOD OF MANUFACTURE.—II.

BY ROBERT G. SKERRETT

In the issue of the Scientific American of February 5th it was shown how greatly the improvements in the power of naval guns are due to the introduction and development of smokeless powder. The present article is devoted to the description of its manufacture.

The base of our smokeless powder is cellulose—that wonderful and yet indescribable form of matter. Cotton is one type of pure cellulose.

In 1832 Braconnot discovered that starch dissolved in nitric acid and when cleansed in water became an intense explosive. A little later, Pelouse obtained the same results by soaking cotton fabrics in that acid

The nitrating house is like a great, gloomy steam laundry—the cotton being digested in centrifugal wringers like those in which clothes are washed.

and then washing them in water. This was the first step in the evolution of smokeless powder. Because of the great violence and erratic behavior of the explosive thus discovered, it took years to develop it into a safe propellant. More than half a century ago, Austria, and later Prussia, used nitrocellulose in their ordnance, but its impetuous action could not then be properly curbed, and a series of accidents and unexpected explosions caused its abandonment. Years later, when the speedy torpedo boat and the rapid-fire gun arrived, French chemists, through stress of need, found ways to check the explosive violence of guncotton and to fashion it into a safe and practical propellant. We followed France, but our powder has been the immediate offspring of that produced by the great Russian chemist Mendeleff.

It seems paradoxical that we should seek for a safer and less violent propellant than common gunpowder by adopting for a base an explosive well known to be more vigorous and more unruly. The secret discovered by the chemists proved nitrocellulose to be amenable to the influence of deterrent agents which subdue the suddenness of explosion, while the form of the grains regulates in a remarkable way the rapidity with which the granules burn and generate the propelling gases. Smokeless powder can now be made in grains of such size and such form that the conditions imposed by each caliber of gun can be met, and the muzzle velocity of the shot regulated with astonishing precision. Thus the task of the ordnance engineer is now quite opposite to that of former days. Today the gun is designed to meet certain requirements, while the propellant is afterward made to suit the gun.

Now for the manner in which harmless cotton is transformed into a ballistic agent at the Naval Powder Factory, Indian Head, Md. No official secrets are betrayed, because the value of the process lies in the nice proportioning of the various ingredients combined with particular forms of grains. These niceties are the outcome of lessons learned after much experimenting, in which the variation of a tiny fraction of an inch may either make or mar the product.

Cotton when steeped in nitric acid becomes soluble in a mixture of ether and alcohol if the percentage of nitration be less than 12.75, and is insoluble when the measure of acid is above this arbitrary dividing line. When below this percentage, nitrated cotton—which by nitration becomes an explosive—may be dissolved into a plastic substance; and when the ether-alcohol solvent has, in its turn, been evaporated the cellulose becomes a hard, tough, translucent mass. Before hardening, however, the stuff is pressed into grains of various shapes which burn with a bright orange flame and without smoke. Our smokeless powder is a brother of collodion so useful in medicine and the art of photography; while celluloid, in its endless applications, is a first cousin, and lies just beyond the dividing line of those substances soluble in ether-alcohol.

The cotton used may be either the blooms straight from the fields or the white mill waste. In either case, the cotton is cleansed by an alkaline bath, and then well dried in an atmosphere of 212 deg. F. The workmen toil in this temperature, but the perfect dryness of the air explains why they are not boiled alive. The object of the drying is to make the cotton more absorptive in the acid, thus insuring more nearly perfect nitration. After the cotton has been dried, it is

The powder is forced through macaroni dies in the form of an endless rope, perforated from end to end with a concentric group of circular passages.

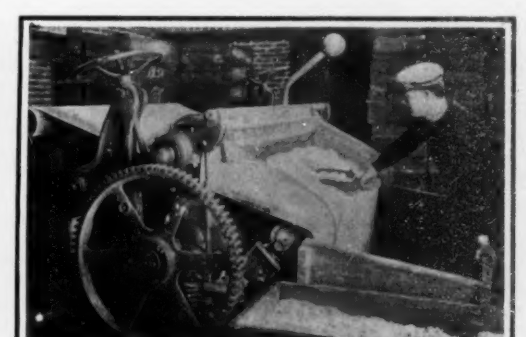
packed in air-tight canisters and sent to the nitrating house, where it is soaked for half an hour in a strong mixture of sulphuric and nitric acids. The reaction frees from the cotton a percentage of moisture which, if not withdrawn, would dilute the nitric acid and affect the character of the product. Sulphuric acid has a strong affinity for water, and it extracts the moisture—thus leaving the nitric acid unimpaired and capable of doing its full work upon the cotton.

The nitrating house is not unlike a big steam laun-

(Continued on page 151.)

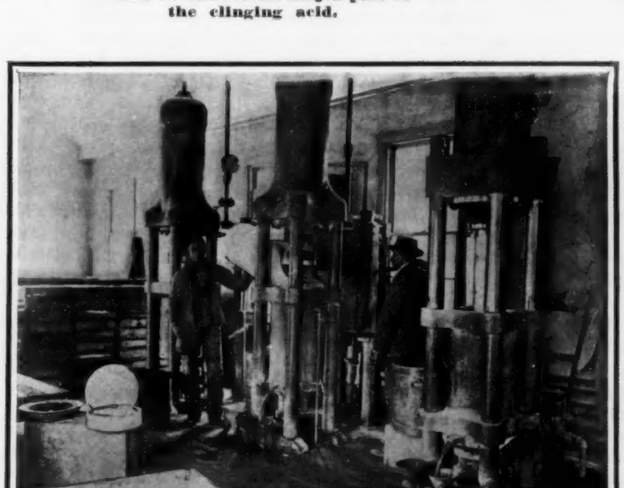
This view shows the important process of washing the cotton in the alkaline bath for the purpose of removing all traces of oil.

The "pyro" is piled into open tubs, and transported to steaming tanks, where it is boiled and boiled to extract the major part of the clinging acid.



Running the fluid pulp through the "wet-machine," whence it comes from the rollers in flakes containing about 40 per cent of water.

One of the mechanical kneaders in which the "pyro" is mixed with the ether-alcohol solvent, and converted into "colloid," before pressing it into solid cylinders.



The dehydrating house, where all but a very small percentage of the moisture is extracted by pressure and finally by the use of alcohol to drive the dampness before it and leaves enough of the spirits behind to form the needful solvent.

In the drying house, where the powder grains are stored away and dried to the proper stage, before testing and sealing away in air-tight tanks

HOW SMOKELESS POWDER IS MANUFACTURED.

A WAY OUT OF THE MARINE TURBINE DILEMMA.

Provided that it can be run at the high speed at which its full efficiency can be assured, the steam turbine is the most economical of all steam engines. On land, as a drive, say, for electric generators, this high speed of rotation can be employed; since a type of generator may be coupled up that is suitable to that speed. When the steam turbine is employed to drive the propellers of a steamship, it is no longer possible to run it at the best speed for economy, and this for the reason that the propeller at the outward end of the turbine shaft shows its own best efficiency at speeds of rotation far lower than those demanded by the turbine. If we run the shaft at the maximum-efficiency speed of the turbine, there will be a big loss of efficiency at the propeller. If we run the shaft at the maximum-efficiency speed of the propeller, there will be low efficiency in the turbine.

Here we have a dilemma which the marine engineer has hitherto found it impossible to avoid. He has attempted to cut the Gordian knot by a compromise, and has tried to find a mean speed of rotation (too slow for the turbine, too fast for the propeller), which would give the best, or rather the least bad results on the "coal per horse-power per hour" basis.

It requires no very keen discernment to perceive that the solution of the problem lies in the selection of some suitable speed-reducing mechanism between turbine and propeller; and as far back as 1904, in a report to George Westinghouse, George W. Melville, the former Engineer in Chief of the Navy, and Mr. John H. MacAlpine, made the following statement: "If one could devise a means of reconciling, in a practical manner, the necessary high speed of revolution of the turbine with the comparatively low rate of revolution required by an efficient propeller, the problem would be solved, and the turbine would practically wipe out the reciprocating engine for the propulsion of ships. The solution of this problem would be a stroke of great genius."

In the intervening years three entirely different methods have been devised for meeting the difficulty. One is to install high-speed turbo-generators, and utilize the current to drive slow-speed motors direct-connected to the propeller shaft; and experimental work in this direction has given such good results that the Fore River Shipbuilding Company recently put in a bid, for the equipment of our 26,000-ton battleships with an installation of this character. In another system, known as the hydraulic-reduction drive, two hydraulic turbines are interposed between the steam turbine and the propeller, the one connected to the turbine, the other direct-connected to the propeller, with controlling valves between the two which enable the speed to be reduced to any desired extent. For both of these systems it is claimed that high efficiency has been secured. The third method (the one shown in the accompanying illustration) consists in the use of a mechanical reducing gear. During a series of exhaustive tests, recently made at the Westinghouse shops, this experimental gear showed the astonishingly small friction loss of one and one-half per cent. These results are far superior to those obtained with the other two methods; and unless some unforeseen disadvantages should develop when the full-size gear comes to be installed on a warship or merchant steamer, it may safely be said that in this reduction gear has been found the final solution of the marine steam turbine problem.

It was no easy task to devise a gearing which would run smoothly and without excessive wear at the high speeds required for steam turbines, and at the same time transmit the thousands of horse-power carried by propeller shafts, which amounts in the case of the "Mauretania" to about 18,000 horse-power per shaft. The experimental gear which is illustrated on the front page of this issue was constructed at the Westinghouse Works at Pittsburg, where it has already undergone, and is still being subjected to, a series of tests. It was realized that if the results were to be convincing, the experimental plant must be on a large scale, and the gear was therefore designed to transmit continuously no less than 6,000 horse-power.

As will be seen from the illustrations, the gears are helical; that is to say, they do not run straight across the face of the wheel parallel to the axis, as in the case of ordinary spur gears, but they are cut in the form of a steep spiral. This construction allows the wheels to roll into contact without shock or jar. Of course, this helical form of tooth causes a strong end thrust in the direction of the axis of the shaft, and in order to prevent this, one-half of the gear was cut with the spirals running in one direction and the other half with the spirals in the opposite direction. In this way the end thrust, due to the obliquity of the teeth, is completely balanced.

In spite of the marvelous accuracy with which the teeth of gears can be cut by modern machinery, it is impossible to form them so truly and align the shafts so perfectly as to get an absolutely uniform contact throughout the entire length of the gear. This is an important consideration in all gears, but becomes doubly so when, as in this case, they may have to transmit from ten to twenty thousand horse-power.

The inventors have met the difficulty by a very ingenious construction designated as a floating frame, which they describe as follows: "The frame which carries the bearings for the pinion is a heavy steel casting supported only at a single point midway between the bearings. This support is flexible, so that the frame is free to oscillate in a vertical plane passing through the axis of the pinion, but is held securely against motion in any other direction. Furthermore, the pinion is free to move endwise in its bearings. Any tendency of the teeth to bear harder at one end of the gear than the other would tend to unbalance the respective end thrusts due to the right and left-hand spirals of the teeth; but as the pinion cannot present any resistance to unbalanced end thrust, it constantly adjusts itself in the direction of its axis to the position corresponding to equilibrium between the opposing forces. This means that the tooth contact pressures are always automatically equalized.

"If there are any minute irregularities in the spacing of the teeth, which would tend to make the contact harder at one point than another in any part of the revolution, this tendency is defeated by the floating frame, the position of which about its central support or fulcrum is controlled solely by the pressures of the teeth of the pinion against the teeth of the large gear. Naturally, the floating frame always yields under the slightest tendency of an unbalanced contact pressure, in such a way as to transfer the smallest increment of unbalancing pressure to another section of the gear that, in the absence of the floating frame, would be less inclined to take its full share of the stress. In short, the gears are self-adjusting to relieve and equalize all abnormal strains, and are consequently independent of the small inaccuracies that are impossible to eliminate in the best commercial manufacturing operations."

The gear was tested by means of a special hydraulic brake, the reduction gear being interposed between the turbine and the brake, and in six tests the brake horse-power delivered by the gear at different speeds varied from 3,712 to 5,927. Since there is no way in which to measure the indicated horse-power of a steam turbine, it was necessary to establish the exact brake horse-power in some other way. Fortunately, it is a characteristic of the steam turbine that, as long as the speed and exhaust pressure are maintained contant, the absolute inlet pressure of commercially dry steam is a very accurate measure of the brake horse-power the turbine is developing. Accordingly, a dynamometer, connected directly to the turbine shaft, was substituted for the reduction gear; the turbine was run at a fixed speed; a constant vacuum was maintained in the exhaust pipe, and the inlet pressures corresponding to different loads at this speed were determined. From these tests the following results were obtained:

B. H. P. delivered by gear.	B. H. P. of turbine as determined from inlet press, etc.	Efficiency.
3,712	3,771	98.7
4,156	4,197	99.0
4,576	4,623	98.9
5,036	5,108	98.7
5,486	5,567	98.5
5,927	6,057	98.7

A reliable check upon these results is afforded by the rise in temperature of the oil with which the gear is lubricated, since the transmission loss in the gear appears as heat in the oil. By measuring the quantity of oil circulated and noting its rise in temperature, a close approximation to the number of British thermal units lost per hour is obtainable. When the gear was delivering 5,088 horse-power, 591 pounds of oil were circulated, with an average rise in temperature of 9.86 deg. F.; from which it follows that the total heat absorbed per hour was 164,208 British thermal units. As 2,545 British thermal units per hour is the equivalent of a horse-power, the total heat accounted for in the oil is 64.17 brake horse-power; and since the total brake horse-power delivered by the gear is 5,088, it follows that the efficiency must be 98.75 per cent. In view of this remarkable coincidence of results, we agree with Mr. H. E. Longwell, the consulting engineer, that the efficiency of the gear is conclusively established as more than 98.5 per cent. The results are, of course, a great surprise and quite unprecedented; but in view of the remarkable adjustability afforded by the floating frame, they are well within reason.

With these results before him, Mr. Westinghouse has made an investigation of the economies which could be secured by applying the gear to the Cunarders "Mauretania" and "Lusitania," which are each capable of developing 70,000 horse-power. If the same high efficiency can be secured on board ship as has been clearly established in the testing room, the results which he arrives at seem to be well founded. It is known that the propeller efficiency in these ships is low, and probably does not exceed 55 per cent. If so, the actual effective propelling power is only about 38,500 horse-power. At the lower speed of revolution resulting from the use of the reduction gear, propellers could be installed that would have an efficiency of not less than 65 per cent; which means that the shaft horse-power required for the same effective propelling power would be less than 57,000—a saving of about 15 per cent. This means that the "Mauretania," without sacrificing her speed of over 26 knots, could reduce the boiler equipment and the coal consumption on each voyage about one-seventh.

But, in addition to this economy at the propeller end of the shaft, there would be corresponding and even greater economies realized at the turbine. For it is well understood that for equal efficiencies in any two turbines the number of rows of blades is, roughly speaking, inversely proportionate to the squares of the respective peripheral speeds of the rotating elements. But the peripheral speed of the rotating elements in the turbines of the "Mauretania" and "Lusitania" is only one-third of the speed common to large turbines used on land. This would mean that to obtain the efficiencies common to the latter, the "Mauretania's" turbines would require approximately nine times as many rows of blades, which would make a machine of prohibitive length. To maintain the same speed of revolution and increase the peripheral speed of the turbines to that of turbines in land practice, the rotors would have to be nearly 40 feet in diameter.

Now, the steam consumption of the turbines of the "Mauretania" is believed to be about 14.5 pounds per shaft horse-power per hour; but it has been proved that in turbines of similar capacity, operating at speeds which the reduction gear makes possible for marine service, the steam consumption does not exceed 11 pounds per shaft horse-power per hour. This means that the boiler capacity, already reduced, as we have seen above by the increased efficiency of the low-speed propeller, could be further reduced to about 45,000 horse-power, and the total efficiency of the whole installation would result in a reduction of over 35 per cent in the coal consumption. These vessels burn about 4,700 tons per voyage; and since the coal costs about $3.25 per ton, the saving in coal alone would be $5,300 per voyage, to say nothing of the reduced cost for wages, food, etc., for the smaller number of stokers that would be required. A further valuable advantage would be that the reduction of over 1,600 tons in the coal required for each voyage would add that amount to the cargo capacity.

But there are further economies, as will be seen by reference to the illustrations on our front page, which show the space occupied by the present turbine equipment of the "Mauretania" and that necessary if small high-speed turbines combined with reduction gears were employed on three propeller shafts. These remarkable engravings speak for themselves, and further comment is unnecessary.

All the advantages that would result from the employment of this device on merchant steamers would be realized also on naval vessels, together with other collateral advantages due to the fact that the high-speed turbine would not suffer the large drop in economy which results, in the case of the present turbines, when they are operating at cruising speeds. With the superior steam economy of the high-speed turbine the boiler capacity would be reduced fully one-third, and with the same bunker capacity the radius of action would of course be enormously increased—a consideration of incalculable importance in the extended operations of a naval campaign.

The Current Supplement.

Among the big things which the big State of California produces are ostriches. These birds are discussed by C. F. Holder. Mendel's laws and the origin of species are popularly discussed by Prof. Otto N. Witt. Herbert A. Humphrey writes on an internal-combustion pump and other applications of a new principle. His aim has been to produce a pump of more simplicity and strength of construction, in which the explosive force is exerted directly upon the water, and in which no rotating flywheel, solid piston, connecting rod, crank bearings, or glands of any sort are required. He describes the results of his experiments with very successful types of pumps, which have been set to work on a sufficiently large scale to demonstrate their utility and economy. Some interesting notes on Halley's comet appear in the current SUPPLEMENT, No. 1780, together with an illustration showing how the earth will be immersed in the comet's tail on the night of May 18th next. The second installment of the paper of Munroe and Hall on combustion and explosion—a primer on explosives for coal miners—is published. Dr. Ludwig Staby writes on the earth's pendulation and its effect. Census Director Duran contributes a most interesting description of the methods to be followed in the present census for counting our population by machine. The death of Delagrange calls forth an article on aeroplane accidents.

Notes on Halley's Comet.

EPHEMERIS OF HALLEY'S COMET.

Computed at Goodsell Observatory.

Greenwich Midnight 1910		α 1910.0 h. m. s.	δ 1910.0 ° ′ ″	log r	log Δ	Br.
Feb.	3	0 59 44.3	+8 14 54	0.1914	0.2398	17
	4	0 58 23.8	8 12 33			
	5	0 57 04.6	8 10 22			
	6	0 55 48.2	8 08 22			
	7	0 54 33.9	8 06 30	0.7843	0.2489	17
	8	0 53 21.6	8 04 47			
	9	0 52 11.3	8 03 13			
	10	0 51 02.9	8 01 47			
	11	0 49 56.2	8 00 29	0.1564	0.2570	18
	12	0 48 51.2	7 59 19			
	13	0 47 47.8	7 58 17			
	14	0 46 46.0	7 57 22			
	15	0 45 45.7	7 56 33	0.1375	0.2639	19
	16	0 44 46.8	7 55 51			
	17	0 43 49.2	7 55 15			
	18	0 42 52.9	7 54 45			
	19	0 41 57.7	7 54 20	0.1177	0.2696	20
	20	0 41 03.5	7 54 01			
	21	0 40 10.3	7 53 47			
	22	0 39 18.1	7 53 38			
	23	0 38 26.7	7 53 33	0.0968	0.2740	22
	24	0 37 36.2	7 53 33			
	25	0 36 46.4	7 53 37			
	26	0 35 57.3	7 53 45			
	27	0 35 08.9	7 53 56	0.0748	0.2769	24
	28	0 34 21.0	7 54 10			
Mar.	1	0 33 33.6	7 54 28			
	2	0 32 46.7	7 54 48			
	3	0 32 00.1	7 55 10	0.0515	0.2782	27
	4	0 31 13.9	7 55 35			
	5	0 30 27.9	7 56 02			
	6	0 29 42.1	+7 56 30			
	7	0 28 56.5	+7 57 00	0.0270	0.2779	30
	8	0 28 10.9	7 57 31			
	9	0 27 25.4	7 58 03			
	10	0 26 39.8	7 58 36			
	11	0 25 54.2	7 59 09	0.0012	0.2758	34
	12	0 25 08.4	7 59 42			
	13	0 24 22.4	8 00 15			
	14	0 23 36.1	8 00 47			
	15	0 22 49.5	8 01 18	9.9740	0.2717	39
	16	0 22 02.6	8 01 48			
	17	0 21 15.2	8 02 16			
	18	0 20 27.4	8 02 43			
	19	0 19 39.1	8 03 07	9.9457	0.2652	46
	20	0 18 50.2	8 03 29			
	21	0 18 00.7	8 03 48			
	22	0 17 10.6	8 04 05			
	23	0 16 19.9	8 04 18	9.9164	0.2563	55
	24	0 15 28.5	8 04 28			
	25	0 14 36.4	8 04 33			
	26	0 13 43.6	8 04 35			
	27	0 12 50.1	8 04 33	9.8865	0.2443	66
	28	0 11 55.8	8 04 26			
	29	0 11 00.9	8 04 14			
	30	0 10 05.4	8 03 58			
	31	0 9 09.2	+8 03 37	9.8569	0.2289	82

During December Halley's comet became bright enough to be seen with telescopes. Several have reported views of it with four and three-inch telescopes. Prof. Philip Fox, director of Dearborn Observatory, saw it during the total eclipse of the moon on the morning of November 27th with the 3¾-inch finder of the 18-inch telescope.

According to the Harvard Astronomical Bulletin No. 379, Prof. E. E. Barnard photographed the comet with the Bruce telescope on December 29th, and finds upon the photograph a very faint tail in position angle 69 deg. with a length of 10 min. The tail was very slender and straight.

According to Prof. E. B. Frost, director of Yerkes Observatory, Halley's comet will be visible to the naked eye about April 1st. It will cross the face of the sun on May 18th, at which time the earth will be plunged in the comet's tail for a period of several hours. The time of the comet's transit will be rather unfavorable for eastern observations, but undoubtedly it will be observed from the Lick Observatory in California and through other western telescopes. The comet will be visible to the naked eye about April 1st in the morning sky just before sunrise. After it crosses the sun it will appear in the evening sky just after sunset.

Atmospheric Electricity as a Source of Power.

The futility of the schemes often promulgated for utilizing the electricity of the atmosphere, with its tension of many thousand volts, is made plain by the following considerations. According to the most reliable measurements that have been made, the strength of the current flowing from the air to the earth is about 10^{-16} ampere per square centimeter. The maximum tension may be estimated at 100,000 volts. Hence the influx of energy per square kilometer cannot permanently exceed $10^{-16} \times 10^{5} \times 10^{10}$ watt, which is equal to 1/10 watt. This is equivalent to 1 kilowatt for each 10,000 square kilometers (3,861 square miles) or 1 horse-power for each 7,460 square kilometers (2,880 square miles) of the earth's surface, and amounts to about 50 horse-power for the whole of the German empire, and 50,000 horse-power for the entire surface of the globe.—Prometheus.

What is declared to be the largest and most expensive leather belt ever made for driving purposes has been recently shipped from New York. The belt is 240 feet long, 6 feet wide, three ply thick, and was constructed at a cost of $7,200. To make the belt the hides of 540 steers were required.

Correspondence.

THE FIRST "ALL-BIG-GUN" SHIP.

To the Editor of the SCIENTIFIC AMERICAN:

In glancing over your issue of November 20th, I was struck by your correspondent's interesting article, "A Dreadnought of 1863." However, does it not seem more logical to go back a year earlier to Ericsson's "Monitor," which was without doubt the first "all big-gun" ship built. The "Roanoke" was really a combination of the "Merrimac" and the "Monitor," being like her antagonist, a razed frigate, and resembling the "Monitor" in the matter of her turrets; therefore, it appears that the "Monitor" was the original dreadnought, and the present mighty vessels of that class are but the design of the great Swedish-American engineer applied to ocean-going vessels. For be it known that Ericsson never intended to employ the "Monitor" vessels for any other than coast defense duty.

Brooklyn, N. Y. GERALD ELLIS CRONIN.

SIGHTING A RIFLE.

To the Editor of the SCIENTIFIC AMERICAN:

I was interested in Mr. Woodland's article, "Sighting a Rifle," in your January 22nd issue, and I would like to mention a point which I think he has overlooked, viz., the jump of the rifle. This term refers to the angle through which the barrel recoils while the projectile is traversing the barrel. In off-hand shooting, the rifle recoils upward, and sometimes slightly sideways, about a center which is probably a little forward of the butt plate. The correction for this should be applied to both sights, and directly proportional to their distances from the center of recoil; but as the rear sight is very near this center, and has little vertical movement due to the jump, it is sufficient to elevate the front sight through this angle. (This is done by the manufacturer; notice the high front sight of a six-shooter, which always has a considerable jump.) Mr. Woodland's plan was evidently to make the correction on the rear sight only; and while this would keep the front sight lower, and would correct the *angle* of jump, it still introduces a constant vertical error at all ranges—an error equal to the vertical movement of the front sight. While this is small, and perhaps negligible for the 0.22 calibers, it would still affect his calculations slightly. The bullet would strike a little high, tending to intersect the line of sight nearer in the ascending branch, and farther in the descending branch of the trajectory.

Chappaqua, N. Y. A. W. BEDELL.

CURIOUS FACTS ABOUT SQUARES AND CUBES.

To the Editor of the SCIENTIFIC AMERICAN:

I have discovered the following curious facts about squares and cubes. These facts, in my opinion, are interesting from a scientific point of view besides being of some practical use. I shall be very glad to have you publish them if you deem them of sufficient worth.

1. To be a square a number must have for its unit's digit one of the digits 0, 1, 4, 5, 6, or 9. This, of course, is well known, but I put it down as an aid in understanding the other facts.

2. To be a square a number, if its unit's digit be 0, 1, 4, 5, or 9, must have for its ten's digit 0, 2, 4, 6, or 8, i. e., the ten's digit must be zero or an even number. If the unit's digit be 6 the ten's digit must be 1, 3, 5, 7, or 9, i. e., an odd number. If the unit's digit be 5 the final digits of the number must be 025, 225, 0625, or 5625. If the units digit be 0, there must be an even number of zeros at the end of the numbers.

3. A number, to be a square, must have as remainder when "nines are cast out" of it either 0, 1, 4, or 7. Since the sum of the digits of a number gives the same remainder when divided by 9, as when the number is divided by 9, this test is easily applied by dividing the sum of the digits of the number to be tested by 9. To this test I can give an algebraic proof.

4. A number, to be a cube, must have as remainder when "nines are cast out" either 0, 1, or 8. This fact also I can prove by means of algebra.

I can furnish you with a device, if you desire it, by means of which, the squares of the numbers 1 to 25 being given, the squares can be written off in order *ad libitum* without any multiplications.

Normal School, Peterboro. G. H. KIRBY.

MISS PECK AND MRS. WORKMAN.

To the Editor of the SCIENTIFIC AMERICAN:

After her ascent of the lower north peak of Mount Huascaran in Peru in 1908, Miss A. Peck wrote in Harper's Magazine and in other periodicals and papers the following:

"It may be regarded as certain that Huascaran is above 23,000 feet, hence higher than Aconcagua, 22,800 feet, and the loftiest mountain known on this hemisphere. If, as seems probable, the height is 24,000 feet, I have the honor of breaking the world's record for men as well as women."

Knowing from her own statement that Miss Peck made no instrumental observations above 19,600 feet on Huascaran, and believing, furthermore, Aconcagua to be the highest mountain of the Andes, I decided to test the truth of these assertions by sending expert European engineers to make a detailed, up-to-date triangulation of the two summits of Mount Huascaran.

The only previous known measurement of this mountain was made many years ago, which is said to have given a height of 22,180 feet for the south or higher summit.

Prof. Schrader, who a few years ago made the most authentic measurement yet made of Aconcagua, and M. Henri Vallot, both well-known French scientists and heads of the Société Genérale d'Etudes el de Travaux Topographiques of Paris, undertook to assist in getting up the expedition, and gave the matter their close personal attention.

M. de Larminat, expert engineer, who has carried out important survey work for the above society, was selected as chief of the mission. In July, 1909, accompanied by two other competent topographers, he started for Peru.

Favored by good weather conditions and assisted as to transport by the Peruvian government, they executed a careful and detailed survey from the sea to Yungay, and by actual measurement established the heights of four stations in the Black Cordillera, from each of which they triangulated the two peaks of Huascaran; so that Huascaran now stands as one of the most accurately measured high Andean mountains.

The results are: Height of north peak climbed by Miss Peck, 21,812 feet; of south peak, still unclimbed, 22,187 feet. These figures may vary by a few feet, but not many, when the calculations are finally gone over by M. Vallot for verification.

Mount Aconcagua, nearly 22,900 feet, still remains, as I predicted and as Sir Martin Conway and other Andean explorers have always maintained, the highest peak of South America.

Miss Peck's highest ascent to date therefore stands, north peak Huascaran 21,812 feet instead of 24,000 feet, as she estimated it; and she has not the "honor of breaking the world's record," either for men or women, for my two highest ascents of respectively 22,568 and 23,300 feet debar her from that honor in the case of women, while a number of men have made ascents exceeding her highest.

Algiers. FANNY BULLOCK WORKMAN.

Official Meteorological Summary, New York, N. Y., January, 1910.

Atmospheric pressure: Highest, 30.79; lowest, 29.20; mean, 30.10. Temperature: Highest, 51; date, 21st; lowest, 5; date, 5th; mean of warmest day, 46; date, 21st; coolest day, 18; date, 4th; mean of maximum for the month, 38.8; mean of minimum, 26.0; absolute means, 32.4; normal, 30.6; daily excess compared with the mean of 40 years, 1.8. Warmest mean temperature of January, 40, in 1880-1890; coldest mean, 23, in 1893. Absolute maximum and minimum of January for 40 years, 67 and —6. Average daily excess since January 1st, 1.8. Precipitation: 5.61; greatest in 24 hours, 1.58; date, 13th-14th; average for January for 40 years, 3.80. Accumulated excess since January 1st, 1.81. Greatest precipitation, 6.15, in 1882; least, 1.15, in 1871. Wind: Prevailing direction, northwest; total movement, 9,163 miles; average hourly velocity, 12.3; maximum velocity, 56 miles per hour. Weather: Clear days, 7; partly cloudy, 10; cloudy, 14; on which 0.01 or more of precipitation occurred, 14. Snowfall, 16.6. Mean relative humidity, 77.1. Sleet, 5th, 29th. Dense fog, 6th, 21st, 29th.

The Argentine Exposition.

The centenary of the Argentine Republic is to be celebrated by an international agricultural exposition, which is to take place this year. The exposition is to be opened at Palermo (Buenos Ayres) on Friday, June 3rd, 1910, and will close on Sunday, July 31st, 1910. The exposition will be divided into eight sections:

1. Geology, Hydrology, Climatology, and Geography in relation to Agriculture. 2. Machinery and Implements. 3. Rural Engineering. 4. Vegetable products. 5. Animal products. 7. Means of promoting agriculture. 8. Special section for seeds.

Entries and application for space may be written in Spanish, French, English, German or Italian, and should be addressed to the Secretario de la Exposición Internacional de Agriculture de 1910 Florida 316, Buenos Aires, República Argentina. These entries or applications for space must be made on the printed forms which the Secretariat of the Exhibition will furnish to all persons who may apply for them at the offices of the Rural Society at the address mentioned, or to the Argentine legations and consulates abroad. Entries and applications abroad can be presented at the Argentine legations and consulates general on the same dates and under the same conditions as any others.

THE LOWE OBSERVATORY ON ECHO MOUNTAIN, CALIFORNIA. U. S. A.

BY EDGAR LUCIEN LARKIN, DIRECTOR

Do you want to imagine that you can almost near the earth in its turning? No word printed on paper can convey to the mind of a reader this impressive silence above the clouds. When Echo Mountain is within a heavy cloud, the darkness is that of night. From sunset until dawn, when clouds are excessively dense, the jet black solitude is indeed weird. The mind is always profoundly impressed, and imagination is vivid and alert. In the midst of this quietude and darkness, lights are suddenly turned on by a distant hand. Night turns to day. Huge masses of metals and wires in a dynamo in Los Angeles, in rapid revolution, cause the light to flash out on the mountain top. The observatory is on a sharp peak between two immense canyons, deep and wide. The mouths of these chasms cut in herculean rocks are blacker at midnight than the imagination can conceive.

Who knows the meaning of the word *clear?* None is able to understand what clear means if living in a valley. Here on Echo Mountain the atmosphere is so clear that the stars seem near enough to touch, and the mountain air wonderfully pure. The stellar hosts glow with a brilliancy all unknown to those living anywhere near sea level. At all times, save immediately after copious rains, the dust envelope surrounding the earth is visible beneath the summit of the mountain. It covers the entire vista, even out to the sea. To us on the mountain top it seems at times as if every human would choke in this layer of dust. Above us at night, shine Sirius and Vega like huge diamonds; Arcturus and Spica likewise, and above all the giant star-sun Canopus, glittering with amazing brilliancy in the distant south and flashing its rays over myriads of wave-crests tossing in the Pacific Ocean. This, the brightest star in the celestial vault, cannot be seen from the latitude of New York. The magnificent constellations of Orion, Hercules, and the Polar Bear are so beautiful that words are powerless to describe them. It is astonishing to behold the apparent nearness of the galaxy. Mountain perspective, the purity of the air, and freedom from water vapor during two-thirds of the year, combine to form an optical illusion. At times this deceptive influence approaches a night mirage, and one seems to be walking among the very stars. Here the "witching hour" is at sunset, a sunset of orange and flower-laden plains, and watery wastes beyond. Round and about the winter solstice the solar disk may be seen standing on the sea. Soon half of the mighty sphere only is visible. The last view is comparable to an arc light. Then one by one the first magnitude stars are seen, flashing between distant peaks. Before the last gleam of the sun has vanished, Aldebaran, Altair, Rigel, and Procyon illumine the sky.

Many gigantic sentinels, peaks, and summits lift their heads within a radius of a hundred miles of the peak. These lie to the east, to the north, and toward the sea in the west. The effect is that of an amphitheater. The south is open even down to the beach. At sunset, large steamers look small indeed when compared to the face of the adjacent sun. Artists have journeyed to Echo Mountain to paint its sunset splendors, to imitate nature on canvas. But brush and pencil are as impotent as words. The view of clouds presented herewith is one of hundreds of thousands. When the first rays of the rising sun strike such cloud banks as these, prismatic colors are seen that defy description—gorgeous oranges, carnations, and heliotropes beneath. The effect is heightened by the singing of birds over the canyons. As the sun rises above the horizon the blossoming plains below, the domes and spires of Los Angeles and Pasadena, surrounded by acres of roses, with beds of delicate wistarias, and rows of flaming red poinsettias, become visible. As the clouds are dispelled, miles after miles of trained cypress, pepper, orange, lemon, apricot, almond, walnut, prune, peach, pear, and nectarine trees, together with hundreds of long lanes, drives and roads adorned on both sides with tall, graceful eucalyptus trees, are seen.

Carpet a floor with jet-black velvet, and throw down upon it a myriad of diamonds in wild confusion, and perhaps you may conceive how the densely packed Milky Way appears from the observatory. Millions is a word becoming astronomically obsolete; billions of stars is an expression much more nearly true of the Milky Way. Billions of suns appear in the infinite deeps of the Galaxy. These constitute the apparent cosmic floor, the base of Nature, and of the stellar structure. In hundreds of areas, there does not seem to be place for more stars. Millions are finer than the points of fine needles, and these make a pavement of starry sand. I never really saw this sidereal base until with the telescope up here. After several days of rain, the atmosphere is swept clear of dust. Then one is really within cosmic deeps when the telescope suddenly sweeps over fathomless interstellar chasms, doors or windows through which one apparently looks into the very bottom of space. These areas are absolutely black. No sensation within the entire range of stellar research, at the hour of a mountain midnight, is so completely overpowering as the vision of an abyss in the stellar floor. Round and about these blackened wastes, there are cases where the stars are piled in heaps, raked into windrows, or strewn out into wisps, streamers, filaments, and spray. Yet of all these stellar hosts the tiniest point may be a white hot sun, and larger than our little star—the sun.

The giant nebula of Orion is a mass of starry lace, a fabric loaded with glittering points.

An astronomical telescope reverses all objects before it. The rotation of the earth is very apparent on Echo Mountain. With high powers, the stars go racing across the field of view. An incredibly startling effect is obtained when the telescope is set upon the Galaxy or Pleiades just as they rise out of some distant peak, or better, over the rim of the eastern canyon. Then millions of stars seem to be pouring into the depths of the rock-hewn abyss descending low beneath the observatory. Floods of stellar points flow downward, as seen in the reversing eyepiece.

The observatory on Mount Lowe is 70 feet in length. The peak had to be cut down to admit the foundations. The telescope is a fine Alvan Clark equatorial, with 16-inch objectives. A fine Brashear telespectroscope is here, and many other instruments.

An inclined electric-driven steel cable draws two cars from the deeps of Rubio Canyon to the summit of Echo Mountain. The length of this railway is 3,000 feet, vertical ascent 1,325 feet, and time of ascent and descent 8 minutes. The altitude of the observatory is 3,420 feet, and is 4 miles from Pasadena, 13 from Los Angeles, and 18 from the nearest shore line of the Pacific.

The railway from Los Angeles through Pasadena and Altadena lies in between orchards of orange trees. Golden fruit may be seen during five months of each year. Almond trees in bloom and orange flowers and ripened fruit are objects eliciting the admiration of all.

This observatory was founded by the dean of living aviators, Prof. Thaddeus S. C. Lowe, in 1894. Dr. Lewis Swift was astronomer in charge until August 11th, 1900.

Grand panorama from Echo Mountain. Looking due south from the Lowe Observatory.

Land area is 900 square miles. The cloud is exactly over Pasadena. The observatory is shown in the foreground. Los Angeles is to the right of this view

THE LOWE OBSERVATORY ON ECHO MOUNTAIN, CALIFORNIA, U. S. A.

A Kinematograph Rifle Target.

Among the novel uses for which animated photographs have been utilized, one of the most ingenious is that recently perfected by two English inventors, Messrs. J. Paterson and J. T. Musgrave. This is its application to rifle-fire practice, the idea being to render the eye of the marksman keener, and to enable him to be more expert in the quick handling of his arm.

The "bioscope target," as it is called, is of very simple construction and operation. There are two rollers, upon which is wound a sheet of paper of any desired size, like the films of a camera, the clear space between the two rollers comprising the screen upon which the pictures are thrown. The lantern is placed behind the marksmen in such a way that their movements do not interrupt or interfere with the projection. Immediately behind this paper screen is a self-recording target system, which instantaneously conveys the value of each shot to an indicator at the firing point. The value of these hits may be graduated as required. Thus the maximum points corresponding to a bull's eye are given for a fatal shot, another value for inflicting upon the objective a mortal wound, another for temporary disablement, and so on. The indicator not only communicates the individual hit, but at the completion of the round, or practice, registers and gives the total value of hits made.

The range can be varied from 15 to 25 yards as desired. The paper screen as it is destroyed by the bullet perforations is wound up on the second roller. The self-recording mechanism behind the screen is so arranged that it absolutely synchronizes with the movements of the object in the picture, at which aim is taken, so that there is no possible chance of a wrong value being given for an individual shot. The indicators are placed immediately above the marksman's head at the firing position, and a fatal hit can be signified by the ringing of a bell, as with the ordinary

bull's eye target. The pictures, which have been specially prepared for use with this apparatus, are of such a character as to develop the celerity and certainty of the marksman's aim to the supreme degree. There is a scout scene, the enemy appearing on the picture first at a relative 100 yards range. He drops on his knee and fires point blank at the marksman a certain number of rounds, corresponding possibly to a complete charge of his rifle magazine. The marksman using the target raises his rifle immediately the kinematographic scout is seen, but does not commence firing until the scout opens fire, the appearance of a puff of smoke in the picture indicating the commencement of firing.

The scout then retreats at the double to a distance corresponding to 200 yards range, when the same cycle of operations is repeated. The scout then retires once more until he reaches a point corresponding to 500 yards range, and the same tactics are once more carried through. It will be seen that in each phase the target becomes decreased in size, according to the range, and at the maximum range offers a very small object to the marksman. Moreover, the fact that the latter has to discharge the whole of his rounds in the short period between the picture scout commencing and finishing firing at each distance, in order to score, indicates that aiming and firing must be accomplished very quickly. Yet it has been found that in the course of but little practice, the marksman can pick up the range and conform with the firing conditions so expertly that about ninety per cent of fatal shots can be got in with each round at the respective ranges.

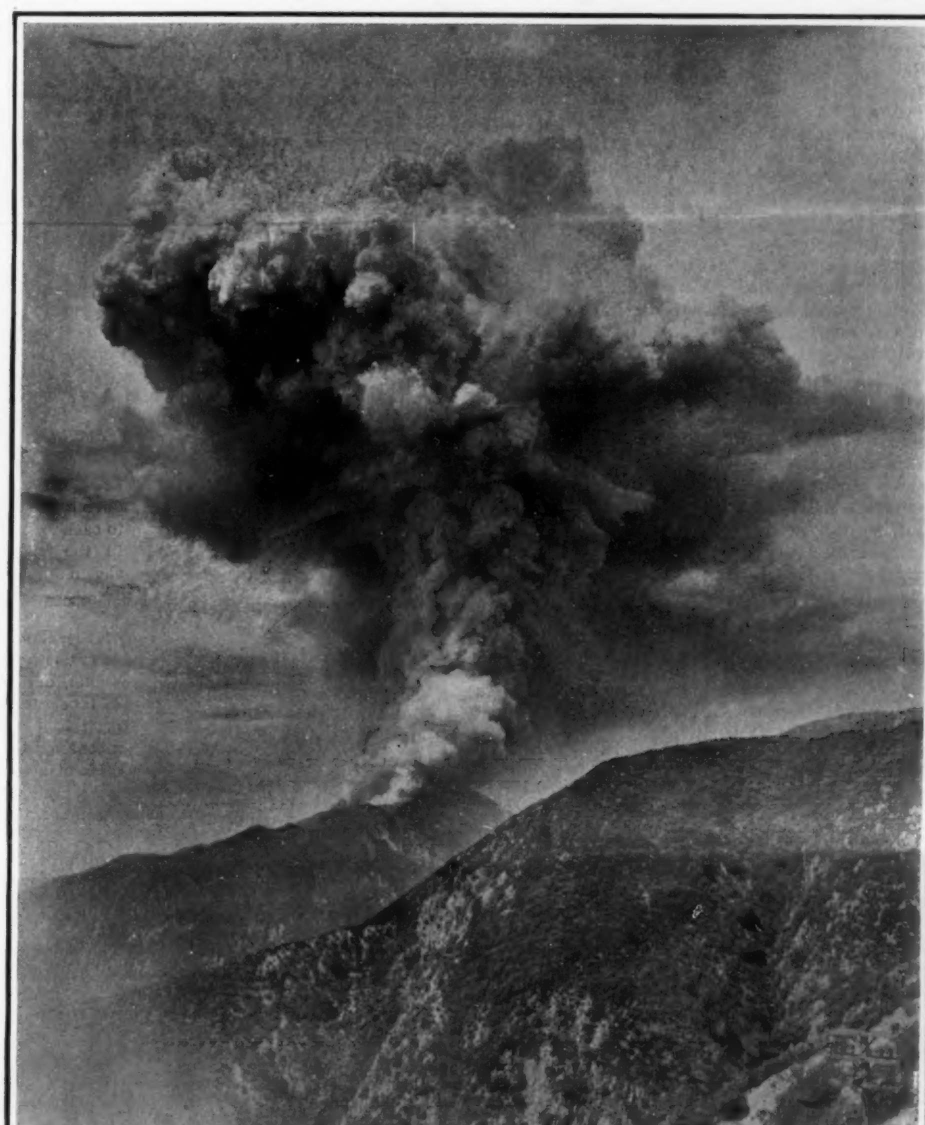
The invention is also applicable to training in revolver shooting, and for this work an ingeniously suitable film has been prepared. It portrays a conflict with an armed housebreaker. The burglar effects his entrance through the window, under which in the room, a roll-top desk is drawn at an angle. In the course of his work the burglar is disturbed, presumably by someone entering the apartment. He instantly shields himself behind the desk, exposing but his head and shoulders, and cocks his revolver. The burglar's disturber is represented by the marksman at the firing point, who at the psychological moment the burglar is about to fire, empties his revolver. In this act the burglar presents a fair-sized target, with his protruding head and shoulders at a few yards range. The burglar having emptied his arm turns to escape through the window, but in the act of dropping from the sill, to which he clings by one hand, he raises his head, and drawing his revolver once more, fires. The marksman waits until he sees the burglar's head fully exposed and just about to fire, and then shoots. In this case, owing to the greater range and the small area offered by the man's head and shoulders in profile, the area offered to the marksman's aim is somewhat small. The burglar indicator represents in silhouette the head and shoulders of the burglar in the two firing positions, and the vulnerable points of this part of the anatomy are shown on the indicator, so that the firer can instantly determine whether he has struck the target in a fatal spot, has inflicted a mortal wound, or has either missed entirely or only inflicted a flesh wound.

The projection is automatically controlled. The lantern is electrically driven by means of a small motor, and this is operated from the firing position by means of a small switch. The same picture can be projected time after time, there being automatic devices for winding and rewinding the spool preparatory to projection. Being electrically driven, a uniform projecting speed is secured, and as it is directly under the control of the marksman, the apparatus is only set in action when required.

The idea can be developed to an indefinite extent, and the variety of pictures that can be used for improving the fire of the marksman is endless. It can be adapted for individual or company firing, and very realistic scenes can be pictorially produced. The application of the bioscope to this phase of military training has often been advocated, and indeed attempted, but hitherto it has been found difficult to evolve a practical simple apparatus. The British War Office has investigated and subjected the invention to searching tests, and has ascertained that marksmanship can be so rapidly improved by this means that its general introduction into the service is being contemplated.

The cloud splendors of Echo Mountain south of the Lowe Observatory.

The clouds in this picture are about 1,000 feet below the building. Orange tree orchards are dimly seen in their shadows below.



This is not a volcano in eruption but a forest fire 6 miles west of the Lowe observatory, which fire started in La Canada Valley and traveled its way to the summit, burning for several days. Colossal flames and smoke looked like a volcano in action.

THE LOWE OBSERVATORY ON ECHO MOUNTAIN, CALIFORNIA, U. S. A.

A new method of bonding new concrete to old was described by Mr. Frank Barber, of Toronto, in a recent article in the Canadian Engineer. This consists in placing bags of cracked ice on the last surfaces of concrete placed at night, thus reducing the temperature of the concrete, and, consequently, retarding its time of setting, so that on the next morning the surface is still plastic, and the concrete then placed will set in one mass with the old. The invention of this scheme is credited to Mr. O. L. Hicks, when he was contractor for a reinforced-concrete truss bridge in Ontario. As all of the members of these trusses were of relatively small cross section, the ice bags were easily placed in position, at the end of a day's work, and it is stated that the method worked very successfully. To what extent it could be applied to heavier work is not as yet known.

Hitherto dew has been used as a beverage only in poetry, by the sun, flowers, and butterflies. It has recently been robbed of all its poetic character by being used for the refreshment of English soldiers. The English administration at Gibraltar, where water is very scarce, now collects dew by the following very simple method. A large pit is dug in the earth and covered with dry wood or straw, which, in turn, is covered either with earth or with sheet iron. The straw or wood serves as a heat insulator, and effectually prevents the conduction of heat from the ground to the layer of earth or the sheet iron, above. Consequently this earth or iron cools after sunset much more rapidly than the ground, so that its temperature soon falls below the dew point of the surrounding air. Hence dew is formed upon the iron or the layer of earth in very large quantities. The water thus obtained is drained off into reservoirs and after clarification is used for drinking.

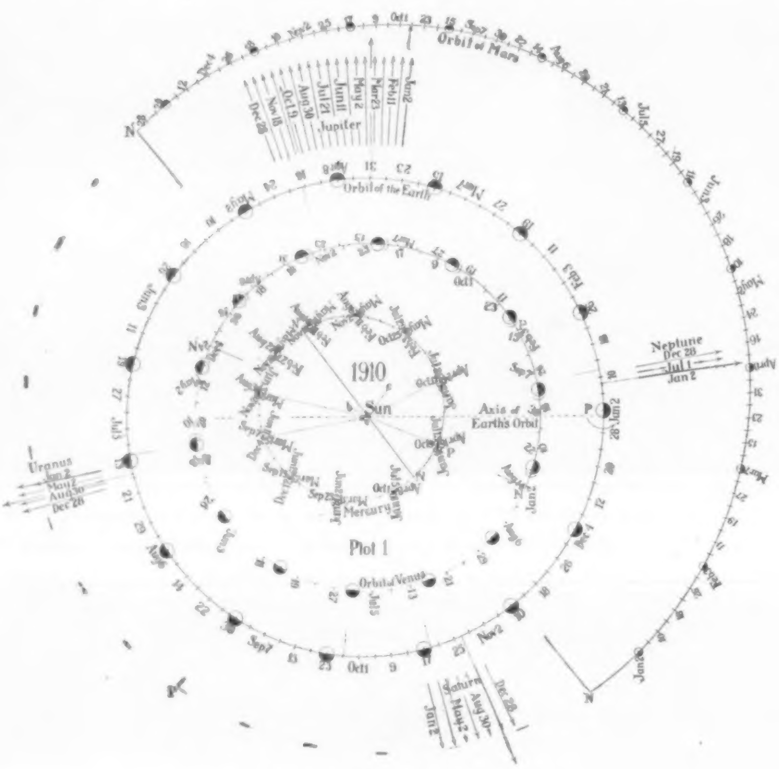
MORNING AND EVENING STARS FOR 1910

BY PROF. FREDERIC R. HONEY, TRINITY COLLEGE

The popular expression "morning and evening stars," while signifying those planets which at different periods illuminate our skies, the observer will naturally include in his study of the heavens the fixed stars whose name indicates that they will be invariably found in the same places on the celestial sphere. Their positions in the heavens may be sooner fixed in the memory by first observing the stars of higher magnitude, whose conspicuous brightness easily distinguishes them from those of varying degrees of lesser brilliancy. In this way the heavens may be triangulated visually, and in process of time all the constellations may be easily identified. For such observations a star map is indispensable; and the positions of the stars should be located by right ascensions and declinations, which are given in the Nautical Almanac. The position of the celestial equator, from which declinations are measured, may be determined approximately by observing the stars which are near it on the star map; and in the same way the position of the first meridian, intersecting the celestial equator at a point from which right ascensions are measured, may also be defined. Following this method, seven-eighths of the celestial sphere (at latitude 40 deg.) will come within the range of vision, and the heavens may become an "open book." The distances to the fixed stars are so great that (except to the astronomer) their apparent positions are not disturbed when the earth reaches the opposite point in its orbit—a distance equal to about one hundred eighty-six million miles. For purposes of observation, the earth may therefore be regarded as the center of the celestial sphere, around which the stars appear to revolve once in a sidereal day, which is nearly four minutes shorter than an ordinary day, a difference due to the revolution of the earth around the sun once in 365¼ days. During this period the earth makes 366¼ rotations on its axis. As a consequence, the stars rise nearly four minutes earlier every day, and during the year the major part of the celestial sphere comes within the range of vision at any assigned hour of the twenty-four. The positions of the planets are continually changing; and in order to discover the region of the heavens in which to search for them, their situation relative to the sun and earth should be determined as illustrated in Plots 1 and 2. The plots of their orbits have been printed in the SCIENTIFIC AMERICAN in the issues of the following dates: March 17th, 1906; February 9th, 1907; February 15th, 1908; and March 6th, 1909; and the positions of all the planets are shown for every day of each year. Together they exhibit the courses of all the planets for the five consecutive years from 1906 to 1910 inclusive. The orbits of the asteroids, which are between those of Mars and Jupiter, Saturn, Uranus, and Neptune, are too small to be visible to the naked eye; the largest of over six hundred being not more than five hundred miles in diameter. Several of the orbits are very eccentric and inclined at large angles to the plane of the ecliptic.

THE SUN AND PLANETS.

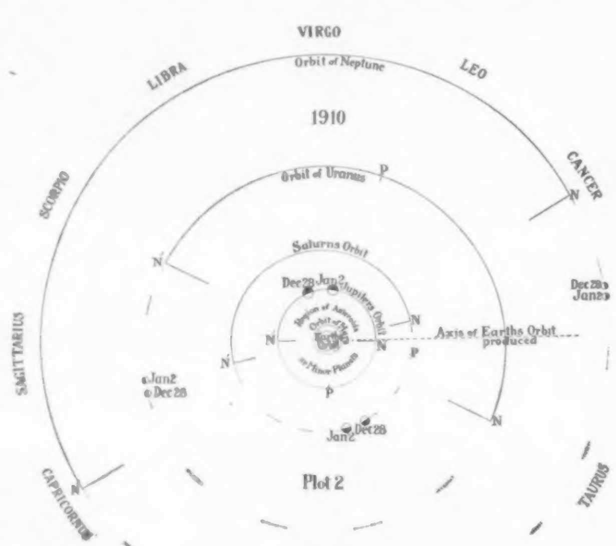
In order to bring the plots of the orbits of the planets within the limits of this page, the orbits of the terrestrial planets, which include Mercury, Venus, the earth, and Mars, are drawn to as large a scale as the space permits. Since the diameter of Neptune's orbit is thirty times that of the earth, the plot of the orbits of the major planets, including Jupiter, Saturn, Uranus, and Neptune, are drawn to a scale which is very much reduced. In this plot the orbits of the earth and Mars are repeated by the reduced scale; the region of the asteroids or minor planets is indicated, and the plots together show the continuity of the solar system. The plane of this paper may be taken to represent that of the ecliptic or the earth's orbit; and if it be placed in a horizontal position, a planet which is on one side may be described as being situated above, and on the other side as below the ecliptic. In the plot of each orbit the full line represents that part which is above, and the dotted line that part which is below the ecliptic. The ascending and descending nodes N and N' are respectively the points where the planet passes from the space below to that above, and from the space above to that below the ecliptic; and P, the perihelion,



PLOT I.—POSITIONS OF THE PLANETS.

is the point of the planet's nearest approach to the sun. A line joining the points N and N', the line of nodes, is the intersection of the plane of the planet's orbit with that of the ecliptic. To avoid confusion, only a portion of this line is represented, except in the case of Mercury's orbit.

It is obviously impossible to represent the diameter of the planets by the same scale. Even those of the giant planets Jupiter and Saturn would shrink to mere points. The same may be said of the sun itself in Plot



PLOT II.—PLANETARY ORBITS.

2; but in Plot 1 its diameter (866,400 miles) would be correctly represented by a measurement a little more than one-half of c, which is the linear eccentricity—the distance from the sun's center to the center of the earth's orbit.

THE EARTH.

The earth's mean distance from the sun (92.9 million miles) is diminished by a little over one and one-half million miles at perihelion in January; and increased by the same distance at aphelion in July. The center of the orbit is at a. At a velocity of 18.5 miles per second the earth moves each day on the average nearly 1,600,000 miles, with an increase of velocity at perihelion and diminution at aphelion; making the complete revolution in 365¼ days. The position of the earth is shown at intervals of four days at Greenwich, noon; and intermediate positions and dates may be interpolated by subdivision.

MERCURY.

The plane of Mercury's orbit is inclined at a greater angle (7 deg.) than that of any other of either the terrestrial or major planets. Its eccentricity is also greater than that of any of the planets. By the eccentricity is meant the distance from the center of the orbit to the sun (the linear eccentricity) divided by the semi-major axis. The linear eccentricity is 7.4 million miles; and the length of the major axis is 72 million miles. Mercury's mean distance from the sun is therefore thirty-six million miles with a diminution and increase of 7.4 million miles respectively at perihelion and aphelion. At perihelion the planet moves at a velocity of thirty-five miles a second, which is diminished to twenty-three miles a second at aphelion. Mercury's orbit is a marked illustration of the first two of Kepler's three laws. First: The orbit of each planet is an ellipse, with the sun in one of its foci. Second: The radius vector (i. e., the orbit radius whose length is continually changing) of each planet describes equal areas in equal times. For example, the area of the triangle with the sun as its vertex, and with a base equal to that part of the orbit included between the dates of August 30th and September 7th, is equal to the area of the triangle with the same vertex and for a base that part included between the dates October 9th and October 17th. In conformity with the second law, the length of the base of the triangle is continually diminishing from perihelion to aphelion, and increasing from aphelion to perihelion; which accounts for the rapid variation in the planet's velocity. Mercury's revolution around the sun is accomplished in very nearly eighty-eight days (87.97). This is repeated over four times during the year, and four dates are attached to each position. Owing to the great variation in the planet's velocity, the positions are shown for every second day.

VENUS.

The orbit of Venus is inclined to the plane of the ecliptic at an angle of 3.4 deg. The eccentricity is less than that of any other planet, and is barely visible in the plot; the distance from the sun to the center of the orbit is less than a half a million miles. As a consequence, the velocity of the planet in its orbit at a mean distance of 67.2 million miles is nearly uniform at the rate of 21.9 miles per second. The period of revolution is 224.7 days. The dates outside the orbit are those which belong to the first revolution; those within, to the second revolution; and that part of the orbit included between the positions of the planet for the first and second revolutions represents the distance traversed in seven-tenths of a day.

MARS.

The orbit of Mars is inclined at an angle of 1.85 deg.; and the center c is 13.2 million miles from the sun. The mean orbit velocity is fifteen miles per second; and the mean distance from the sun is 141.5 million miles. The period is 1.88 years.

THE MAJOR PLANETS.

The inclination of Jupiter's orbit is 1.3 deg., with a linear eccentricity of 23.3 million miles. The planet's orbit velocity is 8.1 miles per second at a mean distance of 483.3 million miles. The period of revolution is 11.86 years. The direction in which the planet is seen from the sun is shown at intervals of twenty days.

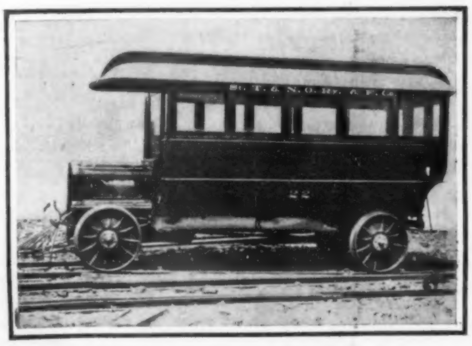
Saturn's orbit is inclined at an angle of 2.5 deg. The eccentricity is nearly fifty million miles; and the mean distance is 886 million miles. The planet's veloc-

(*Concluded on page 153.*)

CURIOSITIES OF SCIENCE AND INVENTION

A STREET RAILWAY AUTOMOBILE.

A steam automobile street railway has recently been installed for regular passenger service between Mandsville and New Orleans, La. The cars are each fitted with a 30-horse-power steam engine and generator, mak-

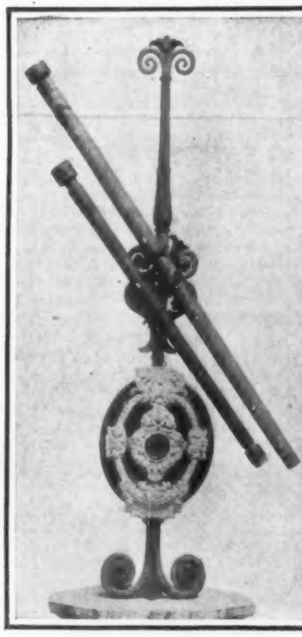


A STREET RAILWAY AUTOMOBILE.

ing them practically automobiles on rails. The line is 16 miles long, and steam motive power has been installed in order to reduce the cost of maintenance. Two street automobile cars built as an experiment have proven so successful that more are now under construction. Each car is built to seat twenty-two people, and the expense of maintaining the line under present power permits of a large saving over the ordinary electric street railway maintenance.

GALILEO'S TELESCOPE.

Just about three hundred years ago, Galileo exhibited a telescope which he had used in studying the moon and planets. This was not the first telescope



THE FIRST ASTRONOMICAL TELESCOPE.

ever built, but it was however the first telescope to be used for astronomical purposes. The accompanying engraving shows how the telescope looked. This type of telescope differs from the present astronomical type in using a concave instead of a convex eyepiece, so that by a combination of but two lenses, the object glass and eyepiece, he was able to view objects right side up, whereas in the present astronomical telescopes objects are inverted. The Galilean type of telescope is now used in the ordinary opera glasses. With this crude instrument Galileo was able to establish the fact that the moon is a round body with its surface broken by mountains, that the Milky Way is composed of countless stars, that Venus and Mercury have phases like the moon, and that Jupiter has a number of satellites (four were discovered by Galileo). To him Saturn appeared to be a triple planet. This puzzling phenomenon was explained fifty years later by Huygens, who discovered that the planet was surrounded by a flat ring.

AN EGG WITH A TAIL.

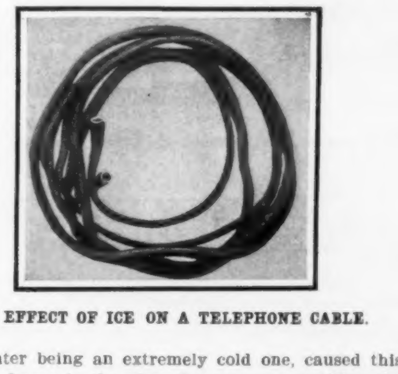
Occasionally, for one reason or another, a hen will lay a "soft-shelled" egg; but one with a tail, like that shown in the accompanying photograph, is decidedly unusual. This egg was evidently the last of

AN EGG WITH A TAIL.

a clutch; and, though the hen lacked material for a shell, she had a surplus for the shell lining, or egg pod.

A FROZEN TELEPHONE CABLE.

The accompanying photograph shows the effect of ice pressure on a twenty-five pair lead telephone cable. The cable was located in a three-inch iron pipe, and was run underground for fifty feet between the terminal pole and the manhole in the street. Owing to a fault in the construction of the lateral, the pipe did not drain into the manhole, which allowed water to collect in the pipe for a distance of about twenty feet.

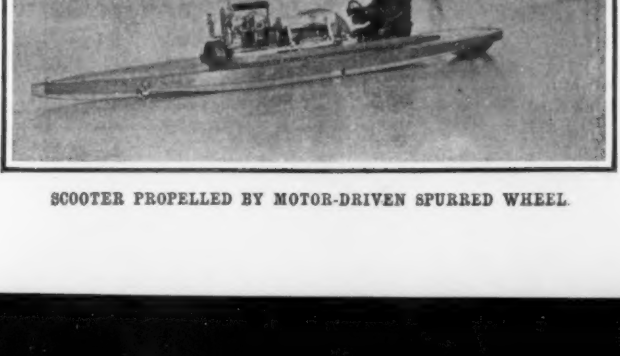


THE EFFECT OF ICE ON A TELEPHONE CABLE.

Last winter being an extremely cold one, caused this water to freeze in the pipe, the pressure crushing the cable out flat. In several places there was a quantity of small stones and gravel in the iron pipe, and so strong was the pressure of the ice in the pipe, that these stones were forced into the armor of the cable as though driven in by a hammer. The wires had the usual paper insulation, and the extreme pressure forced the wire through the paper at every twist of the conductor. The cable was dented and crushed for a distance of twenty feet.

MOTOR SCOOTERING.

Some years ago an amphibious craft was invented at Great South Bay, Long Island, which could be maneuvered on ice as well as in the water. It was in reality an iceboat provided with a flat-bottomed hull which would float the craft in case of encountering a blowhole or break in the ice. The sport proved to be very fascinating, particularly the peculiar sensation of plunging off the ice into the water and then climbing back again. The "scooter," as this craft is named, is now undergoing further development. Instead of depending upon the sail for power, Mr. Nat Roe of Patchogue, L. I., has equipped his scooter with a 30-horse-power motor and a spurred wheel, which digs into the ice and drives the craft along. He claims to have traveled over the ice at a rate of 90 miles per hour. There is no means for propelling the boat while in the water, but the sport consists in leaping gaps in the ice by the sheer momentum of the craft. He has leaped gaps of over a hundred feet in this way. The motor scooter possesses an advantage over the motor sled, because it cannot sink in case of breaking through the ice, and over the sail scooter in the fact that under its own power it can be taken home over snow-covered roads when the owner grows tired of the sport.



SCOOTER PROPELLED BY MOTOR-DRIVEN SPURRED WHEEL.

LARGEST PROJECTILE IN THE WORLD.

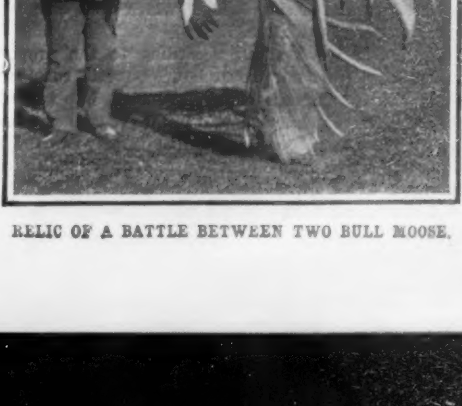
The accompanying illustration is of more than ordinary interest from the fact that it shows the largest

LARGEST PROJECTILE IN THE WORLD.

and heaviest projectile in the world, being the huge 5-foot, armor-piercing shell fired from the United States government's great 16-inch rifle. This giant shell and powerful gun are considered two of the most destructive and deadly engines of warfare in existence. The monster 16-inch rifle, the only one built so far, is now at the Sandy Hook Proving Grounds, and has only been fired a few times. The huge shell of steel can be hurled a distance of 20 miles, or more, and weighs 2,400 pounds. The powder charge is nearly 500 pounds. The cost of firing one shot reaches in the neighborhood of $1,000. It is not probable that this type of gun will be used, but rather the 14-inch, for the main coast defenses of the Panama Canal and possibly the Philippines. This formidable and long range weapon though capable of firing so tremendous a projectile is too costly and fires too slowly for modern warfare.

INTERLOCKED MOOSE ANTLERS.

A curious relic of a fatal battle between two bull moose is shown in the accompanying illustration. The battle was fought in the Kenai Peninsula, Alaska, a few years ago. An Indian was attracted to the spot by the noise of the encounter, and on nearing the two antagonists he found that one had broken its neck during the struggle and lay dead on the ground, while the other, partly exhausted, was making desperate efforts to free his horns. After killing the latter moose the Indian tried in every way to separate the antlers, but found this to be impossible. The interlocked antlers are soon to be exhibited in the collection of heads and horns in the new Administration Building of the New York Zoological Park. The larger pair of horns has a spread of 69½ inches, and the other of 62 inches.



RELIC OF A BATTLE BETWEEN TWO BULL MOOSE.

THE DESIGN FOR THE NEW QUEBEC BRIDGE

COMMONPLACE IN APPEARANCE AND COSTLY TO BUILD

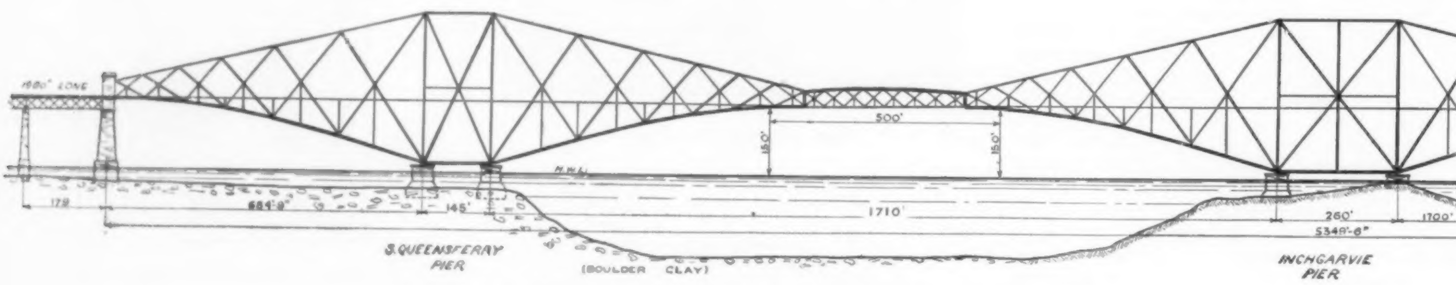
The collapse of the huge cantilever bridge at Quebec on August 29th, 1907, was at once the greatest and most fatal catastrophe in all the history of bridge construction, ancient or modern. When that colossal structure broke down under its own weight and disappeared from sight in the St. Lawrence River, more than eighty human lives and many millions of dollars were lost in the space of a few brief minutes. Naturally, the disaster caused a great loss of prestige to the engineers who were connected with the work, and discredited bridge engineering as carried on in the Western Hemisphere before the eyes of the whole world. The great prominence of this bridge was due to the fact that it embodied the longest span (1,800 feet) yet attempted. This was longer by 90 feet than either of the two large spans (1,710 feet) of the great Forth Bridge in Scotland, which is at present the largest bridge in existence.

An investigation of the facts by a Royal Commission revealed as the cause of the collapse faulty design of the compression members. It was ascertained that the slightest attempt to combine the beautiful with the useful. The faulty structure which collapsed had at least the redeeming feature that the outlines were structurally and æsthetically correct; and although the Forth Bridge has been made the subject of much criticism by the artist and the architect, it must be regarded as having distinct claims to beauty when compared, as on the accompanying page, with the new plans for the Quebec Bridge.

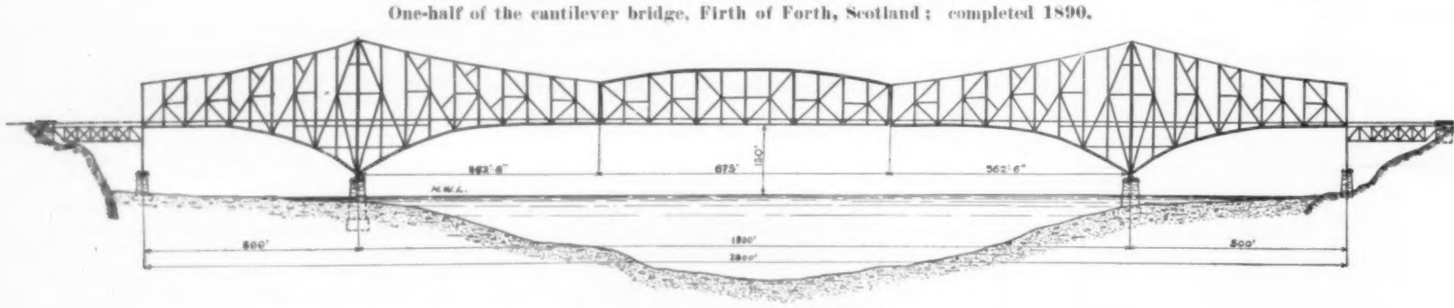
It would seem, however, that the Board has some doubts as to the merits of its own work; for it now invites competitive plans from contractors, which are to be filed by May 1st, 1910; the plans to be drawn at the contractor's own expense. But if the Board has taken eighteen months' time and spent $150,000 to produce the present plans, the public will naturally ask, How can the Board expect responsible firms to furnish them with new plans in one-sixth the time and for nothing?

The lay of the land at the Quebec crossing is such as to make it almost certain that a thoroughly rigid pressure during high gales; and particularly is this provision necessary to insure safety during erection. The bridge which failed was only 67 feet wide, and this small width was a large contributing cause to the twisting of the structure during erection, which preceded its collapse. This important fact does not seem to have been given sufficient consideration; for the new structure has a width of only 88 feet, or one-twentieth of the proposed length of span of 1,758 feet, as against one-fourteenth in the Forth Bridge.

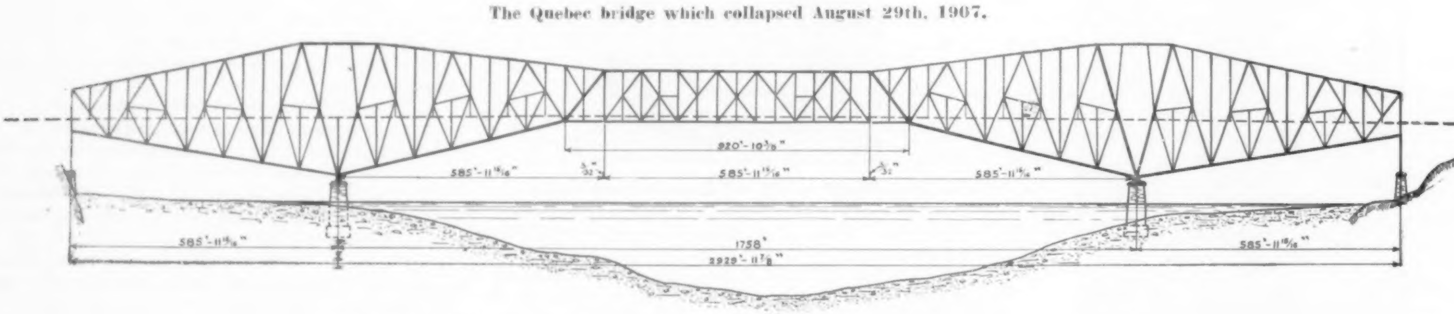
It may be claimed that experience with American practice in cantilever railroad bridges has shown a proportion of 1 to 20 to be sufficient; but it is a question how far their immunity from disaster during erection was due to the fortunate circumstance that no strong winds were experienced—such as frequently occur at the Forth Bridge, and may occur at Quebec—which would have twisted its trusses out of shape before they had been connected up. Moreover, we believe it is a fact that there is not a large cantilever railroad bridge on this continent over which trains



One-half of the cantilever bridge, Firth of Forth, Scotland; completed 1890.



The Quebec bridge which collapsed August 29th, 1907.



The unsightly structure now proposed by the Canadian government for the Quebec bridge.

THE DESIGN FOR THE NEW QUEBEC BRIDGE.

management of the work was so badly organized, that the blame could not be definitely fixed in any one quarter; and in the end the Canadian government had to assume the whole money loss. The work was eventually taken over by that government, and it was decided to rebuild the structure. For this purpose a commission of three engineers was appointed, and it was publicly announced that the new bridge would be the finest and strongest structure of the kind ever seen.

The Commission was appointed about eighteen months ago. In the interim the preparation of the plans has cost about $150,000, and as the result of its eighteen months' work the Commission has produced the very commonplace design, herewith illustrated, regarding which there is a general professional opinion that both structurally and æsthetically it is distinctly inferior to the Forth Bridge, which was completed nearly twenty years ago.

If the bridge is built according to the proposed plans, it will not only be of inferior merit, considered from the bridge engineer's standpoint, but will also be the ugliest bridge of monumental proportions among those hitherto proposed or built. It presents the appearance of a monotonous mesh of triangles and straight lines. From abutment to abutment there is not one graceful line in the whole structure; not the suspension bridge could be built more cheaply, more quickly, and with less risk of failure during erection. On the other hand, if a bridge of the cantilever type is selected, it should be one of the first duties of the Board to see that one of the contributory causes to the weakness of the bridge that failed, namely, its extremely narrow width, is removed. But, so far from doing this, the authorities have not only prescribed certain limitations of width, but they have actually contracted for the new stone piers upon this restricted basis; and it is a fact that the width is such as would put a serious limit upon any bridge engineer who attempted to design either a cantilever or suspension bridge with the necessary cross-sectional width to give the proper rigidity during erection, and subsequently when express trains are crossing the structure. Those of us who knew the late Sir Benjamin Baker, the builder of the Forth Bridge, and were familiar with his cautious methods, will agree that, could he have been consulted, it is more than probable that he would have disapproved of the present design; as he would surely have condemned the old one had it been submitted to him. In his Forth Bridge the width at the base of the towers is 120 feet for a span of 1,700 feet, which gives a ratio of 1 to 14. This large width at the towers is necessary to insure the stability and lateral rigidity of the entire structure under wind dare run faster than 25 miles an hour. The vibrations, due to the narrow width, would become excessive, and at faster speeds would create danger of derailment. On the other hand, the advantages of great width in proportion to length are shown by the fact that the fast and heavy express trains in the north of Scotland pass continually and with absolute safety over the Forth Bridge at their full speed of from 50 to 60 miles an hour.

Another element in the specifications upon which bids are invited which is puzzling engineers and contractors, is that the maximum height of the towers has been limited to 290 feet above the masonry. It really would seem as though the board of engineers who drew up the specifications were desirous to put weight into the new bridge merely for the sake of having it there; for it is well understood that the stresses in the top and bottom members of a truss, and therefore the amount of steel necessary to meet these stresses, increase inversely as the depth, and hence the shallower the bridge, the greater will be its weight. In view of these facts, it is extraordinary that in the specifications the maximum height of the towers above the masonry should be limited to 290 feet. This height in the Forth Bridge is 330 feet, and in the Quebec Bridge which fell it was 315 feet. The

(*Continued on page 154.*)

RECENTLY PATENTED INVENTIONS.

Of Interest to Farmers.

CATTLE-STANCHION.—M. Murphy, Grand Marais, Minn. This improvement allows the cow great freedom of movement, and no possibility of freeing herself from it, as the hook-like spur on the ring which locks the stanchion bar to the rod precludes her from so doing. At the same time the inventor provides for loosely joining the bar at both ends to the upright rod so it can swing freely about the rod without becoming detached.

Of General Interest.

CRATE.—H. H. Cummer, Cadillac, Mich. This crate has a bottom, side walls, end walls and corner posts, each post constructed of sections arranged side by side and having abutting faces, with one of the sections of each post secured to the side walls and the other section of each post secured to the end walls, and bolts or other equivalent devices securing the sections of each post together.

SHOW-WINDOW GUTTER AND FLUSHING.—H. H. Treffer, Davenport, Iowa. The aim of this invention is to provide a gutter which may be disposed under the glass front of the window, and which is adapted to carry away all liquids resulting from condensation and otherwise. Ventilators are provided to maintain a proper temperature within the window inclosure and thus prevent condensation of moisture contained in the air.

METAL STAIRCASE.—J. F. Steiber, New York, N. Y. The improvement refers especially to the means for attaching the treads of the stairs to the staircase or stringers, the object being to provide a simple arrangement for this purpose, and in which no fastening devices passing through the treads are required. The treads are expected to be made of stone, cement or similar material.

PLUNGER-LUBRICATING RING.—H. Ruth, New York, N. Y. This invention relates to a device adapted to keep the plunger of an elevator lubricated in an efficient and thorough manner. It provides means whereby an elevator plunger may be kept thoroughly lubricated by a plurality of lubricating substances, in a simple and efficient manner.

DISPLAY-STAND.—E. T. Palmenberg, New York, N. Y. The object here is to provide a stand for use in stores and other places, and more especially designed for displaying belts and like articles to permit convenient selection by a customer as to style and size, the belts or other articles being securely held in place against abstraction by unauthorized persons, and at the same time to permit a salesman to readily remove any belt selected by a customer.

PIANO-ACTION.—F. B. Long, Los Angeles, Cal. To render the action noiseless, the hammer rail, key board, key or other member of the action is provided on one face with a recess into which is fitted and secured a piece of cork projecting beyond the face of the member, and in the case of the hammer rail or key frame, a strip of felt is secured to the rail and the frame, to overlie the projecting portion of the piece of cork.

TURPENTINE-STILL.—B. Hart, Jacksonville, Fla. In the present patent the invention consists of an improvement in turpentine stills and particularly in means for purifying the gum, etc., by straining the same to avoid the deleterious effect of wood, bark and other impurities being permitted to remain in the still.

Hardware.

SCISSORS AND SHEARS.—A. K. Chapin, Bristol, Conn. In this invention the blades can quickly be adjusted by the employment of a spring device on the pivot, to produce the necessary tension between the blades, and thus bring the cutting edges into correct cutting or shearing position, the arrangement being such that the parts of the spring device are locked in the adjusted position, thus preventing the parts from gradually working loose and hence insuring proper working of the shears or scissors at all times.

Household Utilities.

ADJUSTABLE WARDROBE-BED.—R. E. Carlton, Latonia, Ky. The purpose in this case is to provide a folding bed especially adopted for the use of persons suffering with phthisis, and so arranged as to permit them to breathe the outer air while the body is protected within the house. The bed may be adjusted to any height of window, and to any reasonable size of window opening.

REFRIGERATOR.—L. Doran, Port Arthur, Ontario, Canada. This refrigerator is adapted to be cooled by a cooling liquid rather than by the employment of ice, the construction being such that the liquid is distributed over an evaporating surface and air is caused to circulate over the surface to evaporate a portion of the water and thus lower its temperature.

Machines and Mechanical Devices.

STONE-CRUSHING MACHINE.—I. L. Mitchell, Cedar Rapids, Iowa. This invention is an improvement in that class of ore and stone crushers in which a stationary jaw and movable jaw are arranged opposite each other and the latter is operated by an eccentric to impart a compound movement. It is an improvement in the means for adjusting the movable jaw toward and from the fixed jaw, as required to vary the size of the product.

CRUSHING-MACHINE.—I. L. Mitchell, Cedar Rapids, Iowa. This invention is an improvement in machines in which a movable jaw is arranged opposite a fixed jaw, the two being so placed as to form a hopper or wedge-shape receptacle for the material to be crushed. The movable jaw may be adjusted for crushing finer or coarser. Mr. Mitchell has also invented an improvement in that type of coal, ore and stone-crushing machines in which a movable jaw is pendent from and operated by an eccentric shaft, and arranged opposite a fixed jaw so that they form practically a V-shape hopper for reception of material to be crushed.

REVERSING MECHANISM.—J. R. Golter, Greensboro, N. C. In operation the washing machine is provided with a revolving washer and with gearing at its opposite ends for turning the washer, the gearing being operated alternately to turn the washer in opposite directions so that the strain of turning the washer in one direction is borne at one end of the machine, and the strain of turning it in the other direction will be borne by the opposite end of the machine.

PAPER AND PAPER-HANGER.—W. P. Cronk, Burwell, Neb. One object of the invention is to provide a device in which both the paste and the paper may be held and by which the paper may be pasted by the simple act of drawing it out of the machine. Another object is to provide means for cutting off the paper at the proper length.

THREAD-HOLDER.—J. Rosenberg, New York, N. Y. The invention is an improvement in holders of the character disclosed in Letters Patent formerly granted to Mr. Rosenberg. The purpose is to simplify and generally improve the locking mechanism, which he does by providing a single bolt for each pair of oppositely-disposed arms, the bolts being endwise movable in either direction to alternately engage and disengage the pins.

DETACHABLE PROPELLING MECHANISM.—J. F. Lesko, Chicago, Ill. Generally speaking, the invention consists in a screw propeller operated from the source of power through a suitable train of gears, which is adjustably attached to the stern of a boat by suitable clamps, and which is provided with suitable means to ship the propeller so that it will act at various angles to steer the boat.

BARREL-FORMING MACHINE.—E. P. Everett and G. W. Norton, New York, N. Y. The intention of the invention is to provide a machine having rollers of special form, particularly adapting them for forming the bilge or curvature, and the rolls are constructed and arranged in such a way that the velocity of the faces of the rails on the opposite sides of the web at any particular point is the same.

ANTIRATTLING DEVICE FOR BRAKE-BANDS.—J. Evans, Utica, N. Y. The invention pertains to brake mechanism, such as is used on automobiles and other machines. The aim is to provide a device for preventing rattling of the brake band while the machine is running and the brake band is not in use, the device not interfering with the application of the brake whenever it is desired to do so.

ANIMAL-TRAP.—A. Marchand, Bridgeport, Wash. A main object here is to provide a platform in which the main section is hinged adjacent to the open end of the chamber, and in which the trigger section is also hinged at the edge thereof toward the open end of the chamber, so that the animal in traveling into the chamber will encounter no obstacle in passing from the main section to the trigger section.

Prime Movers and Their Accessories.

VAPORIZER-HEATING DEVICE.—A. E. Osborn, New York, N. Y. This device increases ease of starting internal combustion engines, and is of especial interest, as the fuels used are tending to become heavier and harder to vaporize. The principle employed is the utilization in several ways of part of the heat of a lamp that lights the vehicles' path so that the first charges drawn into the engine will have enough heat to get a good mixture, after which the heat from the engine's operation would take care of vaporization. As the greatest difficulty in starting is at night when lamps are lit anyway, no additional trouble or expense is caused when the device is fitted to the vehicle. In fact, a saving is due to its use, for with certainty of easily starting the engine, there would be no running during stops.

GAS-ENGINE.—G. Dorffel, Fruitvale, Cal., The invention relates to gas or internal combustion engines. One object is to provide means whereby a gas engine of considerable power may be constructed to occupy a comparatively small space, and one in which the cylinders are located radially about the main or driving shaft.

DREDGING APPARATUS.—J. Ostervold, Westport, Ore. An object of the invention is to provide an apparatus for use in removing sandbars, shoals and the like in rivers, harbors and water-ways, which require little power for its operation, and which can be adjusted for use with shoals or other obstructions of different sizes.

Railways and Their Accessories.

TRACK-SANDING APPLIANCE.—F. G. Schwartz, Colorado City, Colo. The invention embodies an auxiliary sand feed receptacle, having discharge openings at either side and a sand supply pipe extending thereinto and terminating above the bottom of the receptacle at or near the level of the openings, whereby the sand is automatically cut off when it is piled up in the receptacle to the bottom of the pipe, leaving the discharge openings free for the delivery of the sand, and air injector nozzles extending into the receptacle and directed to blow the sand through the openings.

Pertaining to Vehicles.

TIRE ARMOR.—C. G. Wright, Greensboro, N. C. The armor disclosed in this patent consists of a metallic band extending around the tire in the groove in the tread. The armor band is provided with suitable spurs and is held in place by straps that extend in transverse grooves in the tire. The ends of the straps inside are bolted to the rim or otherwise suitably secured.

Note.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

NEW BOOKS, ETC.

Kritik der Erfahrung vom Leben. By Justus Gaule, Professor of Physiology in Zurich. Leipzig: Verlag von S. Hirzel, 1906. Two volumes, bound in paper. Price, $1.50 per volume.

The author informs us that this book is the result of twenty-five years of earnest study. In that study he has had in mind the clarification of problems which seemed obscure to him in our conception of reality. He has divided his book into two parts—analysis and synthesis. In the first volume on analysis he discusses theories of the structure of living creatures as unearthed by scientific investigation. It is the purpose of synthesis to reconstruct the desired phenomena from the unities thus obtained. The book differs from most German scientific and biological works because of its simple and even graceful style. There is nothing of that involved Teutonic construction which usually makes German scientific works all but unreadable. Our limited space prevents us from giving more than the chapter headings. The first volume is divided into "general analysis" and "special analysis." Under "general analysis" the author sets forth why a critique of biological experience is necessary. Under special analysis he enumerates the arguments upon which a critique of biological experience must rest. In the volume on synthesis he discusses the structure of living things; symbiosis, hyphoid and zooid; manifestations of life; reproduction; vertebrate organisms; functions of centralization.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. New York: The Engineering Magazine. Pp. 171.

Mr. Emerson is a member of a new profession, viz., the directing of the great forces of manufacturing to the best advantage. He is what is called an "efficiency engineer," which in the vernacular means a doctor for a sick business. In this little book he has laid down the leading principles of this new profession and set forth very clearly the necessity of efficiency engineering to get the most out of men and machines and to cut down waste. Mr. Emerson's main argument seems to be that works management should be essentially military. It must have both line and staff. The line is the general administrative force, which reproduces itself automatically because promotion is by seniority, as in the army. The staff, on the other hand, is composed of men picked out for their peculiar qualifications regardless of age. Just as the youngest captain in the army may be an authority on aeroplanes and their military use, so the youngest man in a machine shop may be an authority on the electric drive. Mr. Emerson's methods have already found application in some of the largest manufacturing and operating institutions in the United States, and have justified his criticisms of the extravagant management of railroads and large industrial works. Particularly valuable are his chapters on the realizations of standards in practice, and the modern theory of cost accounting. As a piece of writing this book may be regarded as a model of forceful and terse English. The author is evidently a man of wide reading, for he is able to illustrate his point with many an apt historical allusion which adds zest to his remarks and makes his book most readable.

The Story of the Comets Simply Told for General Readers. By George F. Chambers, F.R.A.S. Oxford: The Clarendon Press, 1909. 8vo.; pp. 256.

The return of Halley's comet lends to this book a timely interest. The author has collected here all that is worth while knowing about comets in general, and presented his information in a fairly popular style. This book seems to be in every way up to date, for we find in it comments upon Morehouse's comet of 1908, and upon the vagaries of that singular body. More perhaps might have been made of the radiation pressure theory of tail formation, but since the theory is mentioned a criticism on this point might seem captious. After some general remarks on comets, in which their general nature is discussed, the author passes to a physical description of comets. An excellent chapter is that on the tails of comets. In the chapter on movements of comets, the author discusses the periodic and non-periodic comets, together with comet masses and the possibility of collision between the earth and a comet, Jupiter's family of comets, etc. The discovery and identification of comets constitutes the subject matter of still another chapter. Other interesting chapters are those on periodic comets of short periods, lost comets, periodic comets of long periods, Halley's Comet, remarkable comets, the orbits of comets, comets in the spectroscope, the relation of comets to meteors, comets in history and poetry, and cometary statistics. The author has supplied some excellent appendices, including a catalogue of recent comets, and has given a good bibliography and ephemeris of Halley's comet from January to July, 1910.

A Manual of Forensic Chemistry. Dealing especially with Chemical Evidence, Its Preparation and Adduction, based upon a course of lectures delivered at University College, University of London. By William Jago, Fellow of the Institute of Chemistry, Fellow of Chemical Society of Lincoln's Inn, Barrister-at-Law. London: Stevens & Haynes, Bell Yard, Temple Bar, 1909. Pp. 256.

This book is a republication of a series of lectures delivered by the author to the students of University College, London. The lectures were delivered primarily for the assistance of the chemist, and the lawyer in the preparation and adduction of chemical evidence, the lecturer's aim being to get the members of the two professions information for their mutual methods and requirements. With this object in view, the author discusses the nature of chemistry and particularly of forensic chemistry and the range of chemical evidence; the adulteration of food, under the British Food and Drugs Acts; the adulteration of drugs under the British Act; the use or non-use of new manufacturing processes; the use of preservatives and coloring matters; criminal matters; chemical evidence in civil actions and communities.

The Wonders of Mechanical Ingenuity. By Archibald Williams. Philadelphia: J. B. Lippincott Company, 1910. 8vo.; 160 pp. Price, 75 cents.

The present volume is one of Lippincott's Wonder Series, and deals in an interesting way with delicate instruments, calculating machines, workshop machinery, portable tools, oil and gas engines, motor boats, etc.

Presbrey's National Guide for Trans-atlantic Travelers. New York: Frank Presbrey Company, 1909. 18mo.; 128 pp. Price, 25 cents.

This little volume contains a vast amount of information relative to the sea in compact form. It should be in the hands of all ocean travelers. Its use, however, is not limited to the sea, and a copy for reference should be found in every well-regulated library. It is filled with statistical information, plans of the principal ports of call, information as to navigation, etc. No pains have been spared to make this publication an accurate and reliable compendium for the tourist.

The Wonders of the Plant World. By G. F. Scott Elliott, M.A., B.Sc., F.L.S., F.R.G.S., etc. Philadelphia: Lippincott Company, 1910. 12mo.; 155 pp. Price, 75 cents.

The titles of the chapters of this book are as follows: The Activity of Vegetables; On Savages, Doctors, and Plants; A Tree's Perilous Life; On Forests; Flowers; On Underground Life; High Mountains, Arctic Snows; Scrub; On Tea, Coffee, Chocolate, and Tobacco; On Deserts; The Story of the Fields. Many of them are of entrancing interest. One of the interesting bits which we glean from it are that there are 173,706 species of plants, namely: 105,231 flowering plants; 2,819 ferns; 565 horsetails and club-mosses; 4,609 mosses; 3,041 liverworts; 5,600 lichens; 39,663 fungi, and 12,178 seaweeds. These figures are for 1892, but since that time many new species have been described, so that we may estimate that nearly 200,000 species are now known to mankind. This is a sample of the many interesting features which this book has to offer.

The Story of the Submarine. By Lieut.-Col. and Brevet-Col. Cyril Field, Royal Marine Light Infantry. Philadelphia: J. B. Lippincott Company. 8vo.; 304 pp.

In this volume the author, who is known as a careful student of military history, has given an outline of the history of submarine warfare and navigation from the earliest ages to the present day. The absence of technicalities and diagrams is explained by the desire of the author to satisfy the curiosity of "the man in the street," and provide amusement for the casual reader. In this aim he has been successful. The work is clearly written, the illustrations are ample for the purpose, and, as a story, the work is possessed of a decidedly stirring interest. It is not often that an author can be his own artist; but in the present case the whole of the one hundred illustrations are from the brush and pen of

Col. Field. The work possesses the important quality of strict impartiality, and the degree of credit attaching to the several inventors who have assisted to bring the submarine to its present stage of perfection is assigned with excellent judgment.

Canadian Patent Office Practice. Definitions for guidance in preparing and prosecuting applications and other proceedings relating to patents. By W. J. Lynch, Chief Clerk of the Canadian Patent Office, Ottawa: The Mortimer Press, 1909. 114 pp.

Canada is every year becoming a very important country in which to protect inventions, and the number of patent applications filed in the Canadian Patent Office is becoming so great that it is necessary for the authorities to make numerous rules on the many questions which are continually arising. Mr. Lynch, who is the chief clerk in the Canadian Patent Office, has in this book codified the Canadian Patent Act, most of the sections being supplemented with paragraphs in which the practice of the Canadian Patent Office is fully explained. There is no other recent book on Canadian patent practice, to which a practising attorney may turn for reference, and as this book not only contains the law as it has been built up from the many rulings of the Canadian Patent Office, but as it also has been arranged in compact form, there is little doubt that every attorney practising before the Canadian Patent Office will see the necessity of keeping one in his office for constant reference.

Manors of Virginia in Colonial Times. By Edith Tunis Sale. With 67 illustrations, and 22 coats of arms. Philadelphia and London: J. B. Lippincott Company. 8vo.; 310 pp. Price, $5.

The stately colonial homes of Virginia, which in individual cases have been the frequent subject of attention by the artist and descriptive writer, are here treated collectively in a volume of undisputed charm and historical value. Twenty-four of the most notable manors of Virginia have been selected, and the choice has been made with a wise discrimination. In a work of this character there are certain famous manor houses which must inevitably become the subject of more extended notice; and while the description of each colonial home is ample, particular attention has been given to such noble residences as Sherley, Westover, Brandon, Monticello, the noble pile of Berry Hill and Estouteville. Accompanying each chapter is an illustration, generally a front view, of the mansion and a reproduction of the coat-of-arms of the family. Other illustrations show the principal interior views; and particular interest attaches to the excellent reproduction of portraits painted by the early masters of the famous owners of these famous homes. The text is principally concerned with the history of the various families and the personality and fortune of their principal representatives; although in each case there is a brief description of the principal architectural features of the building. This work, which is handsomely printed on heavy deckle-edge paper, is a most valuable addition to the literature on this subject.

Paints for Steel Structures. By Houston Lowe. New York: John Wiley & Son, 1910. 12mo.; 115 pp. Cloth, $1.

Some forty years ago the author of this book had his attention brought daily to the consideration of the manipulation of paint (its properties, and the results of the various operations to which it was subjected) by the questions raised by painters, engineers, architects, builders and constructors. During all this time the author has continued his observations and tests on a scale which has increased in elaboration and with careful attention to every point needing consideration. This little handbook was written by a paintmaker, and is the direct result of study recently given to the manufacture and properties of structural steel and the use of paint in its preservation. It is published in the hope that some of the mysteries heretofore associated with the paint business may be cleared up.

Rhodes's Directory of Passenger Steamers. London: Published for Thomas Rhodes & Co., by George Phillips & Son, Ltd., 1909. 16mo.; 249 pp. Price, $1.

The present volume is based on a publication issued some twenty-three years ago, entitled "Holidays Afloat," and after undergoing various changes, results in its final appearance in this present form. In 1886 the public wanted descriptions of sea trips, the taste for ocean travel then just growing, and "Holidays Afloat" met this demand. The great ocean steamship companies were not slow to perceive that it would be to their interest to publish a series of booklets of a similar nature, and accordingly publications of the kind were put in circulation. It is not easy to sell people anything which they can get for nothing, so that to meet the new conditions, the scope of "Holidays Afloat" was extended, and to the descriptions of sea trips added particulars were of sailing and fares on all the principal lines, forming a sort of Bradshaw of the Ocean, and also a directory of the passenger steamers mentioned in the book, and the publication was renamed Rhodes's "Steamship Guide." But again the demon of generosity appeared on the scene and a large tourist company issued a monthly sailing list which provided more information than could possibly be obtained in an annual, therefore the scope of the book was again changed into a Directory of Passenger Steamers, giving information which would be prized in all parts of the world. The book contains a list of fleets of the principal lines of the world; then follows a directory of passenger steamers giving most valuable information relative to the builders, full dimensions, and something as to speed, accommodations, etc. A new edition is in preparation, which will be reviewed on publication.

The Navigator or Mariners' Guide. A Handy Reference Work for the Use of Navigators, Yachtsmen and Students of Navigation. By Capt. R. M. Pugsley. Jersey City: New Jersey Paint Works, 1905. 8vo.; 202 pp.

Some idea of the importance of this book may be gained from the fact that 30,000 copies have been issued, and the second edition has been revised and added to with valuable matter not generally found in a work of this kind, and which does not exist in a manner conveniently accessible to those for whom this volume is intended, and in so doing the requirements of the practical experienced navigator and the yachtsman and student have been considered with equal care, at the same time preserving the general arrangement of the original work. Only such matter has been introduced as is known to be of real value to those interested in nautical subjects. It is filled with information which is of the greatest possible value to any ship-master or officer. It is well illustrated, and the tables are excellent.

Sicily, the Garden of the Mediterranean. By Will S. Monroe. Boston: L. C. Page & Company, 1909. 12mo.; 403 pp. Price, $3.

The present volume is the result of a tour through Sicily during the past winter and a rather extended study of the history and literature of the island. The aim of the author has been to interest the general reader of travel and description, and to inform prospective tourists of the Garden of the Mediterranean and to refresh the memories of those who may have already made the tour. With these three classes of readers in mind, it has been necessary to cover quite a wide range of subjects of more or less popular interest. The author has placed special emphasis on the distinctly human side of the subject, and, while not neglecting the geography of the island and its diverse physical features, it has been, after all, the Sicilians themselves—their manners, customs, habits and institutions—that have received the lion's share of the book. The illustrations are excellent and are well reproduced. The paper is tinted in *ecru* which is very pleasing to the eye. This book should command a considerable sale.

Der Mensch der Vorzeit. Erster Teil. Der Mensch in der Tertiärzeit und im Diludium. Von Wilhelm Bölsche. Stuttgart: Kosmos, Gesellschaft der Naturfreunde.

In this book Mr. Bolsche has presented a simply worded and therefore popular account of prehistoric man. The usual speculations on the mind of primitive man open the book, whereupon the author passes to important discoveries and deductions to be drawn therefrom.

In the answer to Query 12,165, by an inadvertence we divided the ohms by the volts to obtain the current, instead of dividing the volts by the ohms. Of course everyone would see immediately that this was a slip and not an error of ignorance. We thank our friends for their close watch of our Notes and Queries.

A NOVEL AMERICAN MONOPLANE.

(*Continued from page 140.*)

culated through the bearings and the crankshaft by a gear-driven pump. A narrow Livingston radiator is mounted in front of the motor, a short distance back of the center of the plane. Two torpedo-shaped gasoline tanks connect the two sets of front and rear uprights at the center of the machine.

The single surface of this monoplane consists of seven sections—a central one and three on each side. Both the spars forming the front edge and the rear spar, 10 inches in advance of the rear edge, are divided on each side of the center section into three 5-foot lengths. These spars are jointed together by sheet steel sockets and are securely held in position by cables, forming a double king truss and passing over the king posts located at the junctions of the sections. The cables are attached to drill rod hooks, which are quickly adjusted. Bicycle spoke nipples and eyes are made use of for tightening these cables. Heavy ribs extend from front to rear at the joints of the various sections. These ribs are trussed by an inverted rib and drill rod ties. The single surface, which is formed of Baldwin's vulcanized Japanese silk-proof material, and which is colored black according to the fancy of Mr. Pfitzner, is laced on in sections and is held to the ribs by feather bone and tacks. A section 30 inches long is left out at each end of the plane. This section is to be occupied by the sliding wing tip. These wing tips or equalizers, which are 30 inches wide by 5 feet deep, have the same curvature as the main surface, and are each formed of three ribs connecting a front and rear edge, which slide in a suitable track made of steel tube rails extending the whole length of the outer section of each wing, i. e., 5 feet, and allowing the sliding tip a 30-inch travel. In their neutral position these wing tips extend 15 inches beyond the end of the wing proper. When one is slid out the full distance (30 inches) beyond the end of the wing, the other is drawn in beneath the end of the opposite wing. These tips are connected by a long cable, which passes over pulleys and is wound around the control wheel, so that when the wheel is turned to the right the left wing tip is fully extended, and *vice versa*. As the area of each wing tip is 12½ square feet, when one is fully extended and the other withdrawn, there is a difference in lift at the end of the wings of about 50 pounds at 40 miles an hour, at which speed the machine lifts about 4 pounds to the square foot.

The horizontal rudder in front and the tail at the rear are mounted on two trussed rods extending about 14 feet in front of and 10 feet behind the main plane. The horizontal rudder consists of a main beam about a third of the way from the front to the rear edge, upon which the ribs are mounted. These ribs are connected together by a light front edge of wood and at the rear by a wire cable. The rudder is balanced. At its right end is a double vertical lever, which is connected by wires to a similar lever on the transverse shaft at the base of the control column. The latter lever can be seen in the three-quarter front view of the machine. A forward and backward movement of the control wheel depresses or raises the horizontal rudder. The vertical rudder is connected to the control wheel in such a way that when the wheel is rotated about its vertical axis the rudder is set to turn the monoplane. The motion is the same as that used in steering a bicycle. The vertical shaft of the control wheel is mounted in a 4-inch bearing in the supporting bracket, the transverse steering lever being just below this bearing. Cables connect the ends of this lever to a similar one on the vertical rudder. In order that the length of these cables may remain the same during the fore-and-aft movement of the control wheel, the bracket at the base of the control column is arched so that the ends of the steering lever just mentioned are in the center line of motion. The cable that operates the wing tips, and which is wound around the circumference of the steering wheel in a groove, is led by means of pulleys through the hollow shaft of the control column. It leaves the pulleys in the center line of motion, so that its tension is in no way affected by the other movements of the control wheel. The throttle lever for the carbureter is placed on the side of the control column; a cable passes through this hollow shaft and over pulleys to the carbureter. A switch button for short-circuiting the magneto is also mounted on one of the spokes of the control wheel. This whole controlling mechanism is extremely simple and doubtless will be widely used in the future, as we understand it is the inventor's intention to give it to the public and not to patent it.

All the woodwork used in the construction of this monoplane is of spruce. The spars and struts are solid and have their front and rear edges tapered, while the ribs are laminated. With the exception of the motor, radiator, and steel cables, the whole machine is finished black and

(*Concluded on page 151.*)

Legal Notices

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending February 1, 1910,

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

Acid and making same, indanthrene monosulfonic, R. Bohn 948,204
Acid and preparation of same, ester of diglycolic, L. Ach 948,084
Adjustable coupling, F. Hanson 948,221
Adjustable reel, automatic, C. H. Coon 948,207
Advertising device, E. A. Lyon 948,285
Aigret and like article, artificial, M. Veit 948,194
Air compressor, electric, A. F. Batchelder 947,882
Airship, A. Crane 947,802
Alarm system, O. B. Kaiser 948,055
Apparel, mechanical clasp particularly adapted for wearing, C. M. Friend 948,048
Armor for battleships, E. P. Watson, Sr. 948,196
Ash pan and blower, combined, T. L. Gabbard 947,900
Ash receptacle, Bjork & Willis 947,785
Autographic register, A. Krauth 947,920
Automobile, T. A. Edison 947,806
Axle box, S. T. Bole 948,037
Axle for motor vehicles, supporting, B. D. Gray 947,968
Ballot, mechanical, D. L. Newcomb 947,841
Bar. See Jewel bar.
Battery box, R. W. Magna 948,111
Bean sorting machine, J. Q. Adams 948,123
Bed, Wilson & Brock 948,120
Bedstead, M. G. Merritt 947,836
Bedstead, O. R. Hunt 948,054
Bedstead corner, B. Shapiro 947,858
Belt tightening device, M. J. Stauffer 948,078
Berth, sleeping car, L. J. Berg 948,128
Bicycle attachment, G. T. Sampson 947,945
Billiard cue chalking device, J. C. Morrison 948,114
Binder and punch, loose leaf, J. S. McComb 947,976
Binder, loose leaf, C. F. Hudnall 947,911
Binder, publication, E. B. Arnold 948,125
Binders, extensible pillar or post for loose leaf, J. S. McComb 947,978
Binders, extensible post or pillar for loose leaf, J. S. McComb 947,975
Binders, support for leaves of loose leaf, J. S. McComb 947,977
Blacking machine, boot, A. T. Peffer 947,933
Body brace, R. F. MacClemmy 948,233, 948,234
Boiler, G. Engel 948,271
Boiler cleansing apparatus, J. Zetka 947,955
Bolt heading machine, S. D. & H. T. Latty. 948,060
Boot and shoe uppers, forming, K. Engel 947,895
Bottle cap container, F. Recht 947,847
Bottle, non-refillable, G. A. Roberts 947,852
Bottles, wiring, O. Topp 948,286
Bowling cabinet, R. H. Mulford 948,238
Box-making machine, E. H. Taylor 948,298
Box opener and nail puller, combined, F. T. Lestage 948,230
Box opening device, G. C. Weber 948,152
Brake, W. E. Baldwin, Jr. 948,155
Brake lever, vehicle, J. M. Curter 948,106
Brake shoe holder, G. W. Maples 947,923
Brine cooler, G. Knox ...... 948,14[illegible]
Buckle, J. R. Kidney 947,970
Buckle, ornamental suspender, E. N. Humphrey 948,094
Buggy boot spring, T. Siser 947,949
Bullet, expanding, J. Schenk 948,148
Bundling machine, C. Owens 948,244
Bureau, portable, O. Rangnow 947,939
Burner. See Liquid fuel burner.
Burner, C. C. & H. W. Foote 948,009
Button machine, J. W. Miller 947,995
Calculating machines and the like, carrying mechanism for, D. W. Shiek 948,188
Calendar, J. C. Vaughan 948,263
Cam and tappet mechanism, E. A. Wall 947,874
Can spout, oil, A. P. Hurt 947,991
Cane, walking, L. Alverson 947,984
Cap, Finestone & Marcus 948,273
Car attachment, logging, W. B. Brown 948,159
Car coupling attachment, J. W. Jackson 948,096
Car coupling uncoupling device, J. R. Carmer 948,205
Car door, P. J. A. Schnoor 947,947
Car door fastening, Peakes & Hamlin 947,931
Car door operating device, A. Christianson. 947,793
Car draft rigging, railway, C. S. Shallenberger 947,857
Car dump, G. O. Bradley 948,038
Car fender, J. F. Risdon 947,851
Cars, air intake for, H. W. Leeds 948,144
Card system, N. L. Melancon 948,235
Carpet cleaning machines, pumping mechanism for, W. Schussler 948,254
Carriage, collapsible baby, A. W. Loshbough 947,832
Cash carrier, pneumatic, W. H. Upham 947,872
Castings, mold for hollow, W. T. Bausmith 948,288
Cellulose, manufacture of, E. Morterud 947,974
Cement wall, G. H. Pegram 948,186
Cesspool and trap, J. G. Hayes 947,817
Chair. See Photographic chair.
Chairs, hat holder for theater, H. H. Wilton 948,264
Chalk line holder, J. D. Eastman 947,892
Channel kiln, G. E. Ohrn 948,243
Check, sales, F. G. Lindsay 948,178
Churn, W. H. Brown 948,004
Churn top, L. Lewis 947,922

(*Concluded from page 150.*)

makes a very striking appearance. Mr. Pfitzner has already made a number of short flights, in which he was able to get off the snow-covered ground within a distance of about 100 feet. The machine is very speedy, and so far has shown excellent stability. On one occasion it whirled completely around when the vertical rudder was turned too sharply, and yet in doing this it kept a level keel and was not damaged. The running gear has been broken and will have to be made somewhat stronger, but otherwise the machine has shown itself to be very strongly and well constructed. The novel sliding wing tips used on this machine are quite different from the system of warping the planes used by the Wright brothers, and from the first trial flights at least they appear to be fairly effective. Not until more extended flights have been made, however can their true value be determined.

SMOKELESS POWDER.

(*Continued from page 141.*)

dry in some ways—the cotton being digested in centrifugal wringers of a sort akin to those in which clothes are washed. The atmosphere is intensely acrid, and the stranger coughs in the biting air, to which the throats of the operatives seem to be indifferent. When the cotton has soaked sufficiently, it shows signs of heating by emitting a dense brownish smoke. It is then tumbled into vats of running water, and there "drowned" before being wrung out in another mechanical wringer. The cotton, before innocent, has become an explosive, in fact, is guncotton or pyro-cellulose. Its subsequent stability and value as a propellant now depend upon the thoroughness with which all traces of the transforming acid are extracted from the "pyro," as it is commonly called.

To this end, the "pyro" is next put into open tubs, loaded upon a flat car, and carried to steaming tanks, where for two days it is boiled and boiled to extract the major part of the clinging acid. We know we are dealing now with an explosive by the sharp reports that come from under the car wheels as they pass anon over small bits of nitrated cotton. Next the stewed cotton is taken to the pulping house, where it is pulped and poached like the materials used in paper making. The water is changed often, and after twenty or thirty hours' working, the "pyro" is quite freed of the last trace of acid. These various operations do not undo the nitrating. The chemical metamorphosis accomplished in the cotton by the acid is permanent, and the boiling and washings serve only to remove spent and unabsorbed acid. The slimy pulp is now put through a "wet machine," coming from the rollers in flakes containing about 40 per cent of moisture. Thence it goes to the dehydrating house, where all but a small percentage of the moisture is extracted by successive applications of pressure, and, finally, by the use of alcohol, which drives the dampness before it, leaving just enough of the spirits behind to form the needful solvent when ether is added. The ether is poured in and the stuff is ground and mixed in a mechanical kneader. After half an hour's working, the material resembles damp cracker crumbs. Chemically, the "pyro" is now solvent and has undergone another change, requiring only the proper amount of pressure to produce homogeneity. The "colloid," for such it is, is then pressed into cakes weighing fifty pounds, which suggest soft rubber and are dully resonant. The stuff is no longer white, but looks like syrupy maple sugar. The amber-colored cakes are then subjected to a heavy pressure and the plastic stuff forced through steel collanders, whence it issues in cords like solid macaroni. Again, for the sake of more perfect union, these cords are pressed into a single compact cake, and then the plastic mass is

(*Continued on page 152.*)

(*Continued from page 151.*)

placed within the cylinder of the powder press.

Under an impulse of from 4,000 to 6,000 pounds pressure to the square inch, varying with the size of grain, the powder issues through dies in the form of an endless snake of pale yellow, perforated from end to end with a concentric group of circular passages. As the cord comes from the press it is cut into grains of uniform length; the size of these units and the number of perforations depending upon the caliber of the gun. The purpose of the small lengthwise passages is to insure a compensating burning surface, which increases directly as the external grain surface diminishes under the attack of the flame. This gives the powder its *progressive* burning quality, so needful in securing the desired ballistic results without undue stress upon the weapon.

The actual fashioning of the powder is now complete; but there are still things to be done before it is fit for issue to the service. As it was with the nitric acid, so too is it with the ether-alcohol solvent; the stability of the powder depending upon the degree to which this volatile is extracted. Some of this solvent is removed by distillation, and thousands of dollars worth of it are recovered annually and used again. The final stage of dryness is reached by storage in drying houses, the period varying from six weeks to six months according to the size of the grain. Then, after being tested by actual firing, and mixed with grains of other groups to secure a desired average, the powder is put up in air-tight tanks ready for issue. The object of careful sealing is to arrest the escape of the remaining solvent, which acts as a deterrent and prevents the explosive from becoming too quick in its burning, thus serving to check the development of sudden and dangerously high pressures in the gun.

Smokeless powder can be dampened, and, provided it does not mildew, is as good as ever if properly dried again. After eight or ten years the powder becomes unstable and even crumbles, but it can be sent back to the factory, be reworked, and turned out once more a good explosive at an outlay of only one-fourth of its original cost. This is proof of the indestructible nature of its base—pure cellulose—which however defies the cunning of the chemist and holds secret the ways in which sunshine, oil, and atmosphere work mysterious differences in the minute cells of each delicate filament. The cotton from Georgia does not make the same powder as that from Alabama, and the blooms of Tennessee give us the best propellant. The problem for the manufacturer is to combine these various growths, so that he can make the nearest approach to a perfect and uniform powder. Each lot of powder has its own characteristics within limits; and a sample of each lot is kept under continual scrutiny in a surveillance magazine so long as any of these lots are in service. Daily, these telltale samples are examined. If changes of a vital nature are detected, information is at once dispatched to every ship upon which the affected powder is carried.

Though smokeless powder has proved a boon, still it has one serious fault which has not been effectually overcome; its explosive temperature is quite 4,500 deg. F., and this is nearly twice the melting point of steel—the material from which we make our guns. The development of this intense heat is merely momentary, yet it damages seriously the bore of the gun if the hot gases escape past and ahead of the moving shell, because they act like the flames of a powerful blowpipe and sear away the rifling surfaces of the weapon. Here is a problem for the chemist. Smokeless powder is not as easily ignited as ordinary gunpowder, neither can it be detonated by a blow, and a small quantity of the old black propellant is added to each charge to facilitate

(*Concluded on page 153.*)

Level attachment for straight edges, O. H. Lund 948,232
Light sensitive layer carriers and film structure therefor, device for exposing, J. Schmuck 947,946
Lime and gas, manufacture of, G. G. Floyd 948,045
Line casting machine, B. F. Mercer........ 948,182
Line supporter, H. W. Wells 948,002
Linoleum, manufacture of, W. D. & D. L. Snow 948,189
Liquid cooler, E. Russell 948,252
Liquid fuel burner, F. C. Richardson........ 947,943
Liquid treating apparatus, K. W. Bartlett. 947,783
Loading apparatus, R. C. Gilse 947,902
Lock, J. W. H. Taylor 947,866
Lock, A. Reinikka 947,941
Lock, J. Junkunc 948,280
Locks, stop-work mechanism for, C. A. Berry 948,201
Locomotive, electric, W. E. Woodard........ 948,154
Locomotive engine, H. D. Taylor........ 948,066
Locomotive exhaust pipe, J. Player........ 948,021
Loom shuttle, cotton, V. Leveque........ 947,830
Loom take-up mechanism, A. E. Rhoades.. 948,024
Lubricating, axle boxes and the like, means for, A. J. Smith 948,283
Lubricating device, E. Hutton 948,224
Lubricator. See Force feed lubricator.
Lumber, siding, G. V. Cesiger 948,160
Mail bag deliverer, M. N. George........ 948,217
Mail bags and similar articles, closure for, A. Hormel 948,052
Mail delivery chute, J. & H. Page 947,843
Mail handling device, J. H. Buchanan........ 948,087
Mailing receptacles, card attachment for, A. R. Bingham 948,202
Manifolding devices, carbon holder for, E. E. Everall 948,211
Massager, A. R. Campbell 948,005
Match machine, Tatum & Parker........ 948,027
Match safe, J. S. A. Nicholson 948,017
Measuring and weighing machine, grain, C. D. Cromley 948,289
Measuring machine, grain, C. D. Cromley. 948,290
Merry-go-round, J. S. Tuttle 947,954
Metal frame screen, S. W. McGrath........ 947,838
Metal manufacture, expanded, N. E. Clark. 947,794
Metallic silicids, manufacture of, G. Strauss 948,190
Metering panel board, J. J. Agutter........ 947,956
Milk can, L. R. Steel 947,863
Milk can, glass lined, L. R. Steel........ 947,864
Mill spindle, grinding, A. M. Tully 947,953
Mirrors, pictures, or other small objects, means for supporting, C. B. Moore.... 948,113
Miter box, W. Potter 948,022
Moistening device, P. H. Lombard........ 948,110
Molding box, A. Schrag 948,253
Molding flask drag, W. Fawcett........ 948,167
Mop and hardwood floor device, combination, E. T. Baskin 947,959
Motive power producing machinery, C. Tellier 947,867
Motors, speed multiplying mechanism for, A. L. Heglar 947,908
Musical instrument, mechanical, R. Fromsdorf 947,899
Mutoscope, A. S. Ferguson 948,272
Needle case, J. S. Gardner 947,967
Nickel and copper from ores and mattes, recovering, A. Chalas........ 947,791
Nozzle, exhaust, J. Player........ 948,019
Nozzle for steam boilers, W. Horsley........ 948,053
Nut cracker, S. C. Peckham 947,932
Nut lock, A. A. Brown 948,039
Nut tapping machine, J. Boma........ 947,961
Oil burning system, H. Duke 947,890
Oil switch, H. L. Smith 947,860
Organs, electric coupler action for, J. O. Funkhouser 948,010
Packing, rod, P. Dorsey 947,889
Padlock, combination, L. L. Kellogg........ 947,994
Padlock, combination, L. Rosen 948,251
Paper and other substances, decorative treatment of, H. C. Mitchell........ 947,973
Pencil holder, J. G. Watanabe........ 948,118
Pencil, mechanical, G. Arends 948,124
Pencil protector and sharpener, combination, T. Goodair 947,812
Percolator, coffee, P. Edtbauer 948,108
Photographer's chair, C. E. Herman........ 947,909
Photographic tray, W. G. Rice........ 947,942
Photography, color, F. L. Dyer........ 947,965
Piano shield, M. J. Bean 947,784
Pipe joint packing machine, C. E. Miller.. 947,837
Pipe machine, C. R. Burlingame 948,104
Pipe threading machine, Walter & Troup.. 948,102
Planter, corn, J. C. Coleman........ 947,799, 947,800
Planter, corn, J. N. Stout 948,260
Planter, cotton, J. Clark........ 947,884
Plow attachment, S. B. Evans 948,210
Plow, wheeled, W. L. Paul 948,247
Plug attaching, J. C. Dallam 947,987
Plug, socket, and switch, combined electric connecting, W. W. Buckton 948,041
Pocket knife, I. Kinney 947,823
Post hole digger, E. Sutherland 947,952
Pot handle, pivotal, P. Rotondo 948,187
Powder box, W. H. Perkins 947,934
Powder ejector, Kline & Long 948,057
Presser foot, C. A. Potter 948,100
Printing machine, ticket, Stenhouse & Eastham 948,079
Printing press, web, F. M. Turck 948,261
Projectile, aerial, R. Lehmann 948,177
Pruning implement, C. I. Libby 948,231
Pulley, split, W. H. Stockham 948,080
Pump, J. B. Garber 948,168
Pump, W. H. Heard 948,302
Pump, centrifugal, F. W. Krogh 948,228
Pump coupling, B. F. Mohr 948,072
Pump, multistage centrifugal, A. Giesler... 948,292
Pump, rotary mercury vacuum, H. A. Fleuss 947,988
Pump, G. Clark 948,132
Pumps, counterbalance for water, W. Koethe 948,227
Pumps, valve cage and valve for, J. B. Garber 948,169
Pumping apparatus, F. S. Hebden 948,278
Pyrotechnical button, A. Jedel 948,225
Quoin, J. W. Talbot 948,000
Rack. See Display rack.
Radiator, W. Wilkinson 948,083
Rail joint, F. W. Krueger 947,825
Rail joint, A. A. Lind........ 948,015
Rail joint, J. K. & B. W. D. Gorrell........ 948,069
Rail joint, A. C. Jenrich 948,097
Rail laying apparatus, J. Reinehr 948,023
Railway spike, J. Dellwo 947,887
Railway switches, combined signal and lock for, T. B. Ashford 948,266
Railway switches, trap doors, etc., trip device for operating, F. M. Evans........ 947,896
Railway tie, J. S. Miller 948,236
Railway tie and rail fastening means, J. J. O'Donnell 948,242
Rake. See Hay rake.
Razor and stropper, combined, F. H. Arnold 948,034
Reamer, C. J. Crowley 948,269
Reamer, expansion, W. C. Meyer........ 947,926
Reclining chair, J. E. Trimble........ 948,029
Reflector, C. M. Fluke 948,216
Refrigerating apparatus, H. G. Scherer.... 948,101
Registers, border for side wall, J. Flood... 947,809
Rein button, E. G. Jegge 947,992
Rein holder, A. Crossan 948,162
Rendering tank and press, steam, C. H. Stadler 948,258
Ring gage, G. G. Worstall 947,879
Riveting tool, J. C. Woberman 948,265
Rocket, floating and luminous line carrying, H. E. A. Guerard........ 947,904
Roofing, ready made, W. H. Pendery........ 948,116
Rosette, fuseless, H. C. Wirt 947,878
Rotary engine, W. G. Sheppard 948,256
Rudder for controlling the various movements of screw-propelled vessels and means for operating same, J. P. H. Lund 947,833
Saddle, harness, W. C. Trask 948,081
Saggar, W. W. Babington 947,880
Sand blast machine, C. A. Dreisbach 948,270
Sash lock, window, T. C. Staley 947,950
Sash weight, C. A. Horner 948,171
Saw and handle for the same, J. Ullrich.. 948,151
Saw, bevel, and square, combined, Larson & Hessel 948,059
Saw machine, drag, R. J. McGhee........ 947,928
Saw swage, A. E. White........ 948,197
Scraper, wheeled, J. P. Robbins 947,944
Screw threads upon screws, machine for cutting, W. Avery 948,200
Sealing and stamping envelops, machine for, F. O. Madsen 948,179

(*Concluded from page 152.*)

inflammation. This explains the thin veil of smoke now seen when our guns are fired.

MORNING AND EVENING STARS FOR 1910.

(*Continued from page 146.*)

ity in its orbit is 6 miles a second, and the period is 29.46 years. Saturn's position is indicated at intervals of sixty days.

The plane of the orbit of Uranus is inclined at an angle of 0.77 deg. to the ecliptic, which is less than that of any of the other planets. The mean velocity is 4.2 miles per second at a mean distance of 1,781.9 million miles. The center of the orbit is 82.6 million miles from the sun. The planet completes its revolution in 84.02 years; and its position is shown at intervals of 120 days. Neptune's orbit is inclined at an angle of 1.8 deg. Notwithstanding the planet's great distance, the linear eccentricity is only twenty-five million miles. The orbit velocity is 3.4 miles per second, and the mean distance is 2,791.6 million miles. The revolution is accomplished in 164.78 years; and the planet's position is shown at intervals of 180 days.

Neptune's distance from the sun is a very little over thirty times that of the earth $\left(\frac{2{,}791.6}{92.9} = 30.055\right)$. The square root of the cube of this number gives the period, which is 164.78 years. This illustrates Kepler's third law, viz.: The squares of the periods of the planets are proportional to the cubes of their mean distances from the sun. By similar computations the relations between the periods and mean distances of all the planets may be shown to be those which are here given.

HOW TO DETERMINE THE MORNING AND EVENING STARS.

A planet whose orbit is within the earth's orbit is morning star between inferior and superior conjunctions, and evening star between superior and inferior conjunctions. Prior to conjunction a planet outside the earth's orbit is evening star, after conjunction it is morning star. It should be noted, however, that when a planet is near conjunction, it is not far enough away from the sun for observation. The longest arrows indicate the directions in which the major planets are seen at opposition; the shortest arrows, the directions in which they would be seen at conjunction if the sun were out of the way. At the date of opposition a planet is visible before and after midnight, and is therefore both morning and evening star.

If the page be turned about one-quarter of the way around, so that the earth in Plot I on January 8th (the date of the opposition of Neptune) is between the reader and the sun, the positions of all the terrestrial planets on this day may be seen without turning the head. The earth rotates in the direction of the arrow. At sunrise an observer emerges from the shadow area; at sunset he enters it. All planets which in the plot are on the right rise before the sun, and are morning stars; those on the left set after the sun, and are evening stars. On January 8th Neptune is above the horizon before and after midnight, and is both morning and evening star. Conjunction of Uranus with the sun occurs on the 11th. Previous to this date Uranus is evening star, and subsequently morning star. On January 7th Saturn is at quadrature, and is evening star. On January 4th Jupiter is at quadrature, and is morning star. On January 17th Mars is at quadrature, and is evening star. On January 25th Mercury reaches inferior conjunction. Before conjunction the planet is evening star, and after conjunction it is morning star. During the month of January Venus is evening star. The planet is at inferior conjunction on February 12th, and after this date is morning star.

The table gives the dates of conjunc-

(*Concluded on page 154.*)

Seed linter and condenser, cotton, F. C. Gammons	948,274
Sewer cleaning device, M. Harbeck	947,990
Shafts for vehicles, shifting, W. A. Kitchen	947,824
Shaking screen, C. W. Honabach	948,222
Sharpener for scraper blades, J. F. Weber	947,875
Sharpener, knife and scissors, M. E. Ingram	948,173
Sharpening device, Engelhard & Reinig	948,134
Sheaf carrier attachment, C. M. Hanna	948,013
Sheet metal box, Wootten & Richardson	948,122
Shield, J. A. D'Andelet	948,107
Shipping case or box, T. T. Copeland	947,886
Shirt, combined athletic, W. T. Anderson	948,199
Shock and hay loader, J. Cocking	948,006
Shoe tree, external, H. Stone	947,951
Shoes, sandals, and the like, making, A. B. Eastwood	948,300
Sight feed lubricator, down drop, F. W. Edwards	948,301
Skiving machine, F. L. Alley	948,032
Skiving machine, pressure roll for, F. L. Alley	948,031
Sled and propelling apparatus, A. J. Offord	948,018
Sleeve for garments, S. Karp	948,142
Smelting furnace, J. S. Loder	948,098
Snap switch, H. P. Ball	947,881
Socketed members, securing means for, A. W. Cochran	948,294
Soil antitoxin, making, L. R. Coates	947,797
Soldering the end seams of cans, means for, W. J. Phelps	947,935
Sound reproducing machine record, D. H. Haywood	948,137
Spectacle cases, etc., safety clamp for, J. W. Trulove	948,287
Speed mechanism, variable, H. W. Schatz	948,025
Speed transmission mechanism, variable, H. R. Geer	948,091
Speedometer, J. H. Bullard	947,788
Spindle. See Mill spindle.	
Spool or reel for tape or the like, R. J. Riley	947,997
Springless lock, P. J. O'Brien	947,996
Steam and vacuum trap, C. D. Tillison	948,028
Steam trap, L. M. Cooper	947,801
Steel, J. W. Evans	948,166
Stoker, locomotive automatic, S. D. Griffin	948,220
Stone saw, F. P. Hanson	947,969, 947,989
Stove, F. E. Lesley	947,829
Stove, charcoal, A. W. Stickle	948,259
Stove or cabinet, cooking, C. B. Adams	947,779
Stovepipe ventilator, L. E. Hall	947,816
Strainer, J. M. Mulheir	948,185
Street cleaning machine, J. W. Dougherty	948,164
Strength testing machine, W. H. Johnson	948,140
Surfacing roll, A. Bevan	948,157
Sweeping machine, J. Cable	947,963
Switch throw, H. M. Check	948,206
Table, J. Wallin	947,982
Talking machine, J. B. Browning	948,040
Tank attachment, storage and refrigerating, W. Griesser	948,219
Tantalum, purifying, E. Weintraub	947,983
Telegraph, trolley, and like pole, metal, J. F. Craven	948,088
Telegraphy, directed wireless, Bellini & Tosi	948,086
Telegraphy, wireless, R. A. Fessenden	948,068
Telephone transmitter, E. T. Evans	947,966
Telescope binocular, A. Konig	947,971
Thresher, pea, E. O. Blackwell	948,130
Threshing machine concave, W. L. Hay	948,277
Tie. See Railway tie.	
Tie plate, E. H. Bell	948,127
Tile coating machine, F. E. Goldsmith	948,011, 948,012
Tire armor, C. H. Maddox	947,834
Tire for vehicles, pneumatic, C. E. Titus	948,193
Tire shoes, making, Seiberling & State	948,064
Tire, spring, R. J. Lackner	947,826
Tobacco stripping machine, C. F. Hall	948,136
Tool, compound, J. H. Nantz	948,240
Tool, pneumatic, W. H. Soley	947,861
Toy, A. I. Doerr	948,163
Toy bank, J. F. Schnaffer	947,998
Toy vehicle, J. W. Arney	947,780
Train order catcher, L. C. Schweppe	947,999
Train service coupling, I. R. Turner	948,150
Traveler holders, device for loading, Cobb & Fleming	948,161
Traveling case and bag, S. Grossman	948,170
Trellis, metallic, J. F. Jaquet	947,912
Truck and stand, combined jack, H. N. Day	948,299
Truck, dumping or unpacking, W. V. Ellis	948,043
Truck, locomotive, H. D. Taylor	948,067
Trucks, swivel plate for motor, A. Christianson	947,792
Trunk, hat, O. Rangnow	947,938
Trunk, wardrobe, O. Rangnow	947,940
Tumbling device, B. E. Sawyer	947,855
Turbine, steam, W. Kilmer	948,176
Type setting and casting machine, H. Degener	948,291
Typewriter line lock mechanism, M. B. Sargent	948,147
Typewriting machine, H. L. Wagner	947,873
Typewriting machine, A. G. F. Kurowski	948,058
Typewriting machine, A. C. Smith	948,065
Typewriting machine, O. A. Martini	948,145
Typewriting machine, A. Obernolte	948,146
Umbrella frame, L. H. Carter	947,790
Valve, automatic shut off, M. H. Farley	948,135
Valve, foul gas, O. F. Greim	948,049
Valve gear, engine, G. Horvath	948,223
Valve mechanism for water elevators, J. L. Latta	947,827
Valve, rocker, S. N. Palms	947,844
Vaporizer for medicines, A. G. Whitehorne-Cole	948,153
Vehicle wheel, H. E. Cherry	948,042
Vehicle wheel, O. Schott	948,076
Vending machine, A. R. Jones	948,226
Ventilator. See Stovepipe ventilator.	
Vessel capping machine, J. A. Hicks	948,139
Vessel, submarine, S. Lake	947,921
Vise, Dix & Van Cleave	947,883
Vise, D. Kovacs	947,919
Vote registering machine, D. L. Newcomb	947,840
Voting machine, D. L. Newcomb	947,839
Wagon bolster, spring, J. L. & A. Hagel	947,815
Wagon brake, P. Dockens	948,090
Wagon brake, C. W. Page	948,246
Wagon, dumping, E. E. Geeseman	948,092
Washboiler attachment, W. F. Fessler	948,008
Washing machine, W. M. Kincaid	947,916
Washing machine, J. Schwartz	948,255
Waste and overflow trap, E. W. N. Boosey	947,786
Waste plug mechanism for lavatories and the like, J. Allingham	948,033
Watch holding case, W. E. Porter	947,936, 947,937
Water closet, J. A. Barr	947,782
Water wheel, submerged, W. B. Campbell	948,105
Waves, apparatus for utilizing the movement of the sea, A. Ravelli	947,846
Weed destroyer, P. Hall	947,906
Weighing machine, automatic, A. J. Ball	947,986
Well boring apparatus, A. A. Steel	947,862
Wheel or roller, F. S. Morton	948,063
Wheel rim or felly for pneumatic or solid tires, J. B. Bradshaw	948,267
Wheel rim, supplemental, J. L. Hecht	948,138
Wrench, I. J. Basken	948,035
Zinc, manufacture of, O. Loiseau	947,831

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

(*Concluded from page 153.*)

tions and oppositions. The relative positions of the earth, the planet, and the sun, at conjunction or opposition, may be tested by a straightedge; or the date of a conjunction or opposition may be ascertained by this means. It should be noted that these dates are usually somewhere between those which are given in the plot and between Greenwich noon of one day and the next.

TABLE.

	Greenwich Opposition.	Time. Conjunction.
Neptune	Jan. 8.58	Jul. 11.79
Uranus	Jul. 16.17	Jan. 11.71
Saturn	Oct. 26.87	Apr. 16.62
Jupiter	Mar. 30.75	Oct. 18.71
Mars	....	Sept. 27.21
Venus	....	Feb. 12.00 (inf.)
Venus	....	Nov. 26.04 (sup.)
Mercury	....	Jan. 25.87 (inf.)
Mercury	....	May 25.21 (inf.)
Mercury	....	Sept. 25.83 (inf.)
Mercury	....	Apr. 5.46 (sup.)
Mercury	....	Jul. 19.17 (sup.)
Mercury	....	Nov. 12.08 (sup.)

THE DESIGN FOR THE NEW QUEBEC BRIDGE.

(*Concluded from page 148.*)

low height of 290 feet necessarily increases the weight of a cantilever, and if used for the towers of a suspension bridge would result in a flat catenary, requiring unusually heavy and expensive cables and anchorages. The great height of the towers and trusses in the Forth Bridge has an important bearing upon its rigidity under fast trains.

The effect of low height and narrow width in raising the weights is shown in the fact that the amount of steel to be put into the Quebec Bridge in a length of 2,800 feet is estimated at over 66,000 tons. The total amount of steel in the Forth Bridge in a length of 5,300 feet is 53,000 tons. In other words, the narrow Quebec structure would require the enormous average amount of 24 tons of steel (about half of which moreover is nickel steel) per lineal foot, whereas the wide and rigid Forth Bridge required an average of only 10 tons of carbon steel per lineal foot. It is true that the train loads assumed for the Quebec Bridge are about three times as heavy; but it is well understood that the weight of steel in any bridge of great span does not increase in anything like the same proportion as the live load.

NEW OVERHEAD ELECTRICAL CONSTRUCTION ON THE NEW HAVEN RAILROAD.

(*Continued from page 140.*)

building, through the Westinghouse Company, an experimental freight locomotive, preparatory to operating its whole service, freight and passenger, from New York to New Haven, a distance of between seventy and eighty miles, entirely by electric power.

At the time of its construction the present twenty-three miles of electrified line between Woodlawn and Glendale, two miles beyond Stamford, was one of the most courageous and costly experimental works ever undertaken in the broad field of electricity. The story of the unparalleled difficulties with which the company had to contend in developing the system to its present perfection, and at the same time keeping in operation one of the busiest four-track railroads in the world, has been told from time to time and in considerable detail in these columns. To-day this electric zone is running with the regularity of a watch, as may be judged from the fact that the delays through breakdown of the electrical locomotives are shown by the statistics of operation to be 100 per cent less than were the delays under operation by steam locomotives.

The experience gained during the past two or three years has revealed to the engineers some features in which the electric plant is capable of improvement. Particularly is this true of the overhead

(*Concluded on page 155.*)

(*Concluded from page 154.*)

work, which in the existing line is of a massive and decidedly costly type of construction. In addition to its expensive nature, the present overhead line was found to have unnecessary rigidity; and it was decided that before extending the work to New Haven, it would be wise to build a mile of experimental line, embodying the improvements suggested by past experience. We present two photographs and a diagram which clearly illustrate the character of the new work. In the old construction the line is carried upon massive steel bridges, spaced 300 feet apart, each bridge consisting of a pair of columns supporting a lattice truss which spans the four tracks. Each trolley wire is hung from a pair of steel "messenger" cables by means of a series of triangles, the messengers being hung in a true catenary and fastened to insulators attached to the top of the latticed trusses. The trolley wire, which is maintained in a horizontal position, passes below the supporting trusses. The whole of this system—messenger cables, triangles, and trolley wires—is charged with current at the high potential of 11,000 volts.

In the new system a successful attempt was made not only to lighten the construction, but also to provide one whose appearance would be lighter and more graceful. Furthermore, the cables and wiring have been so arranged that the main carrying cables and the main pipe hangers are not charged, and the only live portion of the work is the catenary, trolley, and contact wires.

By reference to the engravings, it will be seen that the place of the massive bridges is taken by a pair of relatively slender, tapering, columns, which are curved inwardly until they terminate above the centers of the outside tracks. To hold the columns in a vertical position and prevent their sagging under the load of the cables, a length of steel pipe, trussed with wire, is introduced between the opposite incurving ends of the columns. The duty of carrying the wiring falls upon two 1¼-inch steel wire cables, which are secured at the ends of the latticed columns, and extend continuously throughout the whole line. Depending from these cables at intervals of 100 feet are a series of main pipe hangers, each of which consists of a horizontal 3-inch pipe which is hung from the cables above by two pairs of supports formed of 1½-inch pipe. All of this construction thus far described, columns, main cables, and main pipe hangers, is at all times dead, none of the current being allowed at any time to pass through it—a feature of the greatest importance when it comes to the question of making quick repairs to the line, or of adjusting the set of the cables. Attached below the transverse horizontal members of the pipe hanger are four porcelain insulators, which are adjusted so as to lie vertically above the four tracks; and this feature of adjustment is one of the great improvements of the new over the old line. Upon the insulators are strung the four steel track messenger catenaries, below which, carried on short vertical pipe hangers of graduated lengths, is the copper trolley wire. An inch or two below the trolley wire, and supported therefrom by steel clips, is the steel contact wire, against the under side of which the collector shoes of the locomotives bear with an upward pressure of about 25 pounds. The method of attaching the contact wire to the trolley wire at points intermediate with the points at which the trolley wire is itself suspended, provides a system of equalization which gives to the system an even flexibility throughout its whole length, and insures a continuous contact and a consequent freedom from sparking.

The management of the electrical zone of the New Haven Railroad Company and its engineers are to be congratulated in having made such a marked improvement, both from the constructive and æsthetic standpoints, over the existing line between Stamford and New York.